AD NUMBER

AD452585

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; AUG 1964. Other requests shall be referred to Deputy Chief of Staff for Research Development and Acquisition [Army], Washington, DC 20310.

AUTHORITY

DAMA ltr dtd 13 May 1975

RESEARCH
ANALYSIS
CORPORATION

Reconnaissance Techniques for Light Observation Helicopters in a Summer Environment:

A Two-Sided Field Play

The contents of RAC publications, including the conclusions and recommendations, represent the views of RAC and should not be considered as having official Department of the Army approval, either expressed or implied, until reviewed and evaluated by that agency and subsequently endorsed.

FIELD EXPERIMENTS DIVISION
TECHNICAL MEMORANDUM RAC-T-433
Published August 1964

Reconnaissance Techniques for Light Observation Helicopters in a Summer Environment:

A Two-Sided Field Play

by
Harrison N. Hoppes
Barry M. Kibel
Arthur R. Woods

RESEARCH ANALYSIS CORPORATION
McLEAN, VIRGINIA

FOR OFFICIAL USE ONLY

FOREWORD

The Field Experiments Division (formerly the Combat Developments Division) of RAC is attempting to provide timely solutions to current Army problems involving tactics and doctrine. Field Experiments Division researchers have found that one of the most effective means of accomplishing this objective is working with combat-ready forces in sector. This paper describes helicopter reconnaissance experiments conducted near Nürnberg, Germany, with the 2d Sqdn, 4th Cav, 4th Armd Div. This field endeavor represents one of the first two-sided free-play helicopter reconnaissance experiments conducted. Reconnaissance techniques examined include (a) flying just above treetop level, (b) flying nap of the earth, and (c) flying nap of the earth and dismounting an observer to go forward on foot or popping up briefly from concealed positions to observe suspected hostile areas.

Richard E. Tiller
Chief, Field Experiments Division

ACKNOWLEDGMENTS

The authors are deeply indebted to the officers and men of the 15th Cav (now 4th Cav), 4th Armd Div, for their willing and able assistance, especially to Maj Ben Edney, CO, D Trp (Air Cav), 2d Sqdn, 15th Cav, for the stimulative guidance he provided.

The interest and support of Maj Gen John F. Franklin Jr., CG, 4th Armd Div; Col Stansberry, Aviation Officer, USAREUR; Lt Col Clagget, G3 Sec, Seventh Army; and Lt Col Burney, G3, 4th Armd Div are acknowledged and appreciated.

Without the able assistance of the RAC Electromechanical Laboratory this study would not have been possible. Working at times under adverse conditions and doubling as data collectors when the occasion demanded were Mr. Paul F. Michelsen, Mr. Robert E. Shook, Mr. Ronald R. Kessler, and Mr. Kenneth R. Diller.

The following staff members should also be cited for their assistance in various phases of this study: Mr. Andrew J. Eckles III, Mr. Sean P. Foohey, Mr. Baldwin D. Noyes, Mr. Russell Putnam, Mrs. Jean L. Pickford, Mr. Robert Littrell, Mr. Robert A. Charron, Mr. Stephen R. Wax, Miss Georgia Fleming, Mrs. Muriel B. Tullner, and Mrs. Phoebe R. Winfield.

Special thanks go to Lt Col Francis Giacomozzi, CO, 2d Sqdn, 4th Cav, who reviewed this document and made a number of substantive contributions.

The experiments were performed under the sponsorship of the US Army Combat Developments Command. Col Carroll McFalls, Project Advisory Group Chairman, provided his direct support.

CONTENTS

Figures

Tables

SUMMARY

Problem

To evaluate helicopter reconnaissance techniques against diverse ground complexes in terms of relative acquisition capabilities and helicopter survivability.

Facts

Two types of reconnaissance missions are envisioned for the 1965–1975 time frame, the first of which would be a truly high-level area survey of the complete battle area. This might be carried out by fixed-wing aircraft operating at altitudes of 45,000 ft or more. The second type of reconnaissance mission would be battlefield surveillance over forward areas. This might be carried out by unmanned aerial drones, ground-reconnaissance elements, fixed-wing aircraft flying at low altitude, or helicopters of an air cavalry troop.

In a tank-vs-tank exercise conducted in Germany in July 1962 a single helicopter was tactically employed as support to one of the tank forces. Although no conclusions were drawn from this limited activity, the exercise did suggest some interesting implications on the tactical use of helicopters and served as a feasibility study for the work presented in this paper.

Among the advantages of employing a helicopter in a forward-area reconnaissance mission would be its ability to coordinate rapid destruction of the enemy it has located. It may call for artillery fire and adjust this fire by sensing rounds—employing a pop-up tactic. It might, as another alternative, radio for a tank-killer team and coordinate the latter's activity.

In theory the helicopter would be an excellent means of obtaining information of enemy activity in the forward areas and providing immediate feedback to the command position. Its ability to get to the area of responsibility quickly and to make terrain "work for it" to avoid detection while reconnoitering are exploitable characteristics of the aircraft. In practice, however, the selection of a tactic or combination of tactics that best enhances the capabilities of the helicopter in the performance of its mission is not necessarily a well-defined operation.

SUMMARY

Discussion

During the month of July 1963 an experiment was conducted in the area south of Nürnberg, Germany, to determine the effectiveness of three techniques of helicopter reconnaissance: (a) flying high (just above treetops), (b) flying low (nap of the earth), and (c) flying low and popping up from concealed positions or dismounting an observer to go forward on foot to reconnoiter suspected hostile territory. Helicopters were employed singly and in pairs. Three types of target complexes (dispersed, concentrated, and moving) were investigated during 5 days of runs. A total of 27 runs using 40 helicopters were made in the manner indicated in Table 1. Of these 27 runs, 10 were conducted against a dispersed ground complex, 13 against a concentrated complex, and 4 against a moving column.

TABLE 1

Helicopter Reconnaissance Experiment in Germany, July 1963

Flight tactic	Helicopters used		Total
	1	2	
	Runs		
High	6	3	9
Low	4	4	8
Low with dismounts and or pop-ups	4	6	10
Total	14	13	27

Experimental Procedure

The scenarios were designed to be as realistic as possible and still be within the constraints necessary to maintain control. The ground elements (tanks, APCs, jeeps, and infantry) were tactically located to allow for a ground threat as well as one from the air. These elements were required to make both sighting and firing reports. Gun cameras were appended to the firing systems in each position to record data on accuracy and duration of fire.

The OH-13 helicopters reconnoitered their area of responsibility after a briefing on the tactical situation and mission. In performing reconnaissance they were constrained only by the tactic of flight. The path of flight, positions of pop-up or dismounting, speed, and consequently the length of mission were left to the crews' discretion. The aircraft were required to make sighting reports but were instructed not to simulate fire in any situation.

A standard pen recorder was used to record necessary time information. Flight paths were reconstructed from maps drawn by RAC data collectors

positioned in the area and from maps drawn by the pilots who performed the mission. Gunfire simulators, machinegun blanks, and taped combat sounds were included in selected portions of the experiment for added realism.

Limitations

When conducting an experiment of this type in the field, especially with personnel from a tactical unit, certain trade-offs between rigorous experimental design and maintenance of tactical reality are required. The success of such an undertaking depends to a large degree on the cooperation of the US Army and the units involved and on the availability of human and material resources. Conduct of an experiment should provide training benefits wherever possible.

Some observations on tactical limitations should be made. The experiment was performed in the summer, hence the effects of less foliage, snow, overcast sky, reaction to cold, etc. are not known. An experiment comparing helicopter reconnaissance techniques in a winter environment was conducted in January 1964 by the authors of this memorandum, and the results will be published. The direct applicability of the results to a different ground complex, e.g., one that differs in size and composition, is uncertain. Measurements of the several reconnaissance techniques investigated would undoubtedly be affected if the ground complex were confronted with hostile ground as well as air elements. Similarly this would doubtless be the case if helicopters were subjected to hostile air as well as ground attack.

Analysis of Acquisition Data

Statistical techniques were used to analyze the two-sided acquisition data. In these analyses emphasis was placed on investigating the effects of (a) flying high, low, or low with dismount and/or pop-up; (b) reconnoitering against ground units that were moving, dispersed, or concentrated; (c) reconnoitering against target complexes that included various mixes of tanks, APCs, jeeps, and infantry; and (d) employing helicopters singly or in pairs.

In studying the effects of varying these experimental conditions four primary measures of acquisition effectiveness were utilized: (a) the number of one-sided acquisitions, i.e., those instances in which one side saw the other and was not seen in return; (b) the number of interacquisitions, i.e., those instances in which one side saw the other but was later seen in return; (c) the total number of times one side saw the other first; and (d) the number of targets acquired compared with available targets.

Major findings based on acquisition advantage data are summarized as follows:

(a) Helicopters employing the low with dismount and/or pop-up tactic were more effective than helicopters using the reconnaissance tactics of flying high or nap of the earth. Ground units averaged significantly fewer acquisition advantages against helicopters using the dismount and pop-up technique.

As important was the finding that helicopters flying low with dismount and/or pop-up acquired more ground elements without being seen in return than helicopters using the other reconnaissance techniques.

(b) In general the ground elements were far more effective in acquiring helicopters than helicopters were in acquiring ground elements. Ground elements saw the helicopters first in 156 of 193 sightings, or over 80 percent of the time.

(c) Ground elements in a moving column were less effective in acquiring helicopters than ground elements in dispersed or concentrated ground complexes.

(d) Based on the total number of acquisition advantages, smaller ground elements (jeeps, infantry) were more effective in acquiring helicopters than larger elements (tanks, APCs). Stationary units were more effective in acquiring helicopters than moving units were.

(e) Flying in pairs did not increase the acquisition effectiveness of the helicopters. Almost half the helicopter acquisition advantages recorded were scored by single helicopters.

Results of comparisons of air and ground effectiveness on the basis of available targets acquired were:

(a) Ground units saw fewer helicopters when the low with dismount and/or pop-up tactic was used than when other reconnaissance techniques were employed.

(b) In terms of available ground targets acquired by helicopters, however, the low with dismount and/or pop-up tactic was no more or less effective than the high or the nap-of-the-earth tactic. For each of the three reconnaissance tactics studied, approximately 50 percent of the available ground targets were acquired.

(c) More helicopters were detected by dispersed and concentrated ground elements than by moving armor columns.

Analysis of Fire Data

The probability of a target hit was calculated from the gun-camera film for each machinegun burst. Consequently the survival probability for each helicopter for every run was computed at various conditional kill-probability levels. These values were compared to investigate the effects of (a) flying high, low, or low with dismount and/or pop-up; (b) reconnoitering against units that were moving, dispersed, or concentrated; and (c) employing helicopters singly and in pairs.

The findings of the analysis with respect to survivability were:

(a) The technique of flying low and employing pop-ups and/or dismounts was superior to the other two techniques. For example, at the 0.60 conditional kill-probability level, the mean survival probabilities for the flying low with pop-ups and/or dismounts, low, and high techniques were 0.65, 0.30, and 0.19, respectively.

(b) Helicopters were more effective when reconnoitering against a moving complex than a concentrated or dispersed one. For example, at the 0.60 conditional kill-probability level, the mean survival probabilities against the three types of complexes were 1.00, 0.40, and 0.17, respectively.

(c) Flying in pairs did not markedly increase survivability.

Conclusions

1. The technique of flying low and employing pop-ups and/or dismounts is superior to the other two techniques examined.
2. Ground elements in a moving column are less effective in acquiring helicopters and are more easily acquired than are ground units in stationary employments.

Recommendations

1. Reconnaissance helicopters should be employed with due caution against suspected stationary enemy concentrations.
2. Given that it is judged desirable to reconnoiter with helicopters, the technique of flying low with pop-ups and/or dismounting observers from covered positions prior to entering suspected hostile terrain should be used when conducting an area reconnaissance mission.

Reconnaissance Techniques for Light Observation Helicopters in a Summer Environment: A Two-Sided Field Play

FOR OFFICIAL USE ONLY

INTRODUCTION

THE RECONNAISSANCE MISSION

Two types of reconnaissance missions are envisioned by the US Army for the 1965–1975 time frame, the first of which is a truly high-level survey of the complete battle area. This may be carried out by fixed-wing aircraft operating at altitudes of 45,000 ft or higher. The height and speed used will depend on the type of sensing instrumentation, as well as visibility, cloud base, and type of information required. The second is battlefield surveillance over forward areas. This may be carried out by unmanned drone aircraft with several types of sensing instruments such as radar, television infrared sensing, and cinecamera photography.[1] Another method for obtaining information over forward areas would be the employment of the elements of an air cavalry troop. The effectiveness of these elements in performing a reconnaissance mission is the subject of this memorandum.

The majority of missions assigned to armored cavalry units are primarily of a reconnaissance and security nature. The air cavalry troop is designed to extend by aerial means the reconnaissance and security capabilities of the armored cavalry squadron. Reconnaissance elements are not required to destroy the enemy; their function is discovery, not destruction.

As Gen Hamilton H. Howze pointed out in an address in an Army symposium in 1957,[2] the reconnaissance helicopter will fly low to the ground (10 to 12 ft above the terrain) on the fringes of enemy territory. It is realized that reconnaissance of the forward area is dangerous and helicopters will be shot down, but there is no safe way to perform this mission. The helicopter must take maximum advantage of terrain to mask his movement and may choose to land and send forth an observer on foot with field glasses to examine suspected areas before the helicopter flies into them.

It was also stressed in the address that helicopters would be effective in performing a route-reconnaissance mission. In addition they would be a mobile reserve for discovering any enemy attempt at penetration and providing information for counteraction.

THE GROUND THREAT

Two threats[1,3,4] to the helicopter from ground-launched weapons exist, the first being the overall battlefield antiaircraft defense system (the Russians

may be assumed to have an equivalent to Mauler and Hawk); and the second, the weapons of the forward forces including small arms, machineguns, light antiaircraft guns, and, at a later date, missiles.

Helicopters operating in close support of ground forces in forward areas of a future battlefield will be forced to fly at altitudes less than 100 ft to avoid detection and possible subsequent destruction by hostile missiles. This low-altitude flight will bring the aircraft well within the effective range of small-caliber machinegun and light antiaircraft fire from enemy ground troops, as well as small shoulder-launched missiles. To avoid the possibility of alerting the enemy and to minimize exposure if detected, aircraft will fly close to the ground and, where possible, within the cover of wooded areas, utilizing every terrain feature to obtain as much concealment as flying skill permits.

The threat to aircraft will depend on the tactics adopted by the enemy and the method of fighting the battle in an era of tactical nuclear weapons. The following points have been considered in attempting to estimate the probable threat to the aircraft: (a) a potential aggressor will avoid heavy concentrations of men and materiel to reduce the effect of tactical nuclear strikes as much as possible; (b) active reconnaissance will take place and increase when any strong thrust develops; (c) the potential aggressor will be well trained in the use of all weapons in an antiaircraft role; (d) the enemy will know when an advantageous situation for using their weapons against an aircraft develops and will not be reluctant to open fire; and (e) the aggressor will employ larger units than friendly forces employ with mechanized armored elements in support.

Hence, if tactical nuclear weapons are used, ground forces will probably be deployed in small self-contained pockets. The size and armament of these pockets will depend on the military thinking of a potential enemy. According to current estimates the geographical size of the pocket will be roughly 1 km in diameter spaced 4 or 5 km apart.

The type of terrain will radically affect the probability of survival of the aircraft. If the terrain is flat and open, no cover will be available, and slow low-flying aircraft will be extremely vulnerable to fire from the ground. If the terrain is wooded or if terrain masks provide adequate cover for the helicopter, then the chances of survival are drastically increased if proper use is made of the concealment afforded.

BACKGROUND

The Field Experiments Division (formerly Combat Development Division) of RAC attempts to recommend improved tactical doctrine for use in US Army combat operations. First primary area of interest has been main-gun fire doctrine and corresponding tactics for the M60 tank. Investigations were conducted in both the US and Germany.[5]

As a by-product of a tank-vs-tank exercise conducted in Germany in July 1962 a single helicopter was tactically employed as support to one of the tank forces. Although no conclusions could be drawn from such a limited activity, this exercise did suggest some interesting implications of the tactical use of helicopters and served as a feasibility study for the helicopter work presented in this memorandum.[6]

DATA SOURCE

The authors spent the month of April 1963 with D Trp, Air Cav, 2d Recon Sqdn, 15th Cav (later redesignated as 2d Sqdn, 4th Cav) familiarizing themselves with helicopter and pilot performance, discussing problems with the troop commander and other members of the troop, and developing and expanding a framework for the work presented in this memorandum. Company- and squadron-level field exercises were conducted during this period, in which feasibility data were gathered using such collection means as stopwatches and questionnaires.

During the month of July 1963 a field team of the Field Experiments Division conducted an experiment in Germany to determine the effectiveness of the following techniques of helicopter reconnaissance: (a) flying high (just above treetops), (b) flying nap of the earth, and (c) flying low and popping up from concealed positions and/or dismounting an observer to go forward on foot prior to entering suspected hostile territory. The experiment was conducted south of Nürnberg, Germany. Helicopters and helicopter personnel were from D Trp and ground elements and personnel were from A and C Trp of the same squadron.

Dispersed, concentrated, and moving target complexes were investigated over different terrain. Five tactical situations were established for 5 days:

(1) Blue forces, originally positioned behind phase line **OLDPOSE**, withdrew to phase line **RETREAT** (see Fig. 1) leaving a small task force (elements of which were designated A, B, C, D, E) to delay the advance of the enemy. Red forces sent out helicopters to perform an area reconnaissance of the indicated region between the two phase lines (roughly 10 km^2) to obtain information of enemy strength still present in that area.

(2) Blue forces, originally positioned behind phase line **BLUEBOYS**, withdrew to phase line **REDHEADS** (see Fig. 2) leaving a small task force (elements of which were designated A,B,C,D,E) to delay the advance of the enemy. Red forces sent out helicopters to perform an area reconnaissance of the region between the two phase lines to obtain information of enemy strength still present in the region (rougnly 10 km^2).

(3) A small task force of Blue forces was positioned in an assembly area east of Schwabach. An APC mortar fired rounds at Schwabach (simulated by 90-mm flash-bang simulators). The intelligence information of the Red army narrowed the location of the task force to the 5-km^2 area defined in Fig. 3, and helicopters were sent out to pinpoint the location of the enemy.

(4) A small task force of Blue forces was positioned at an assembly point south of Schwabach, where a perimeter defense was set up in a wooded area.

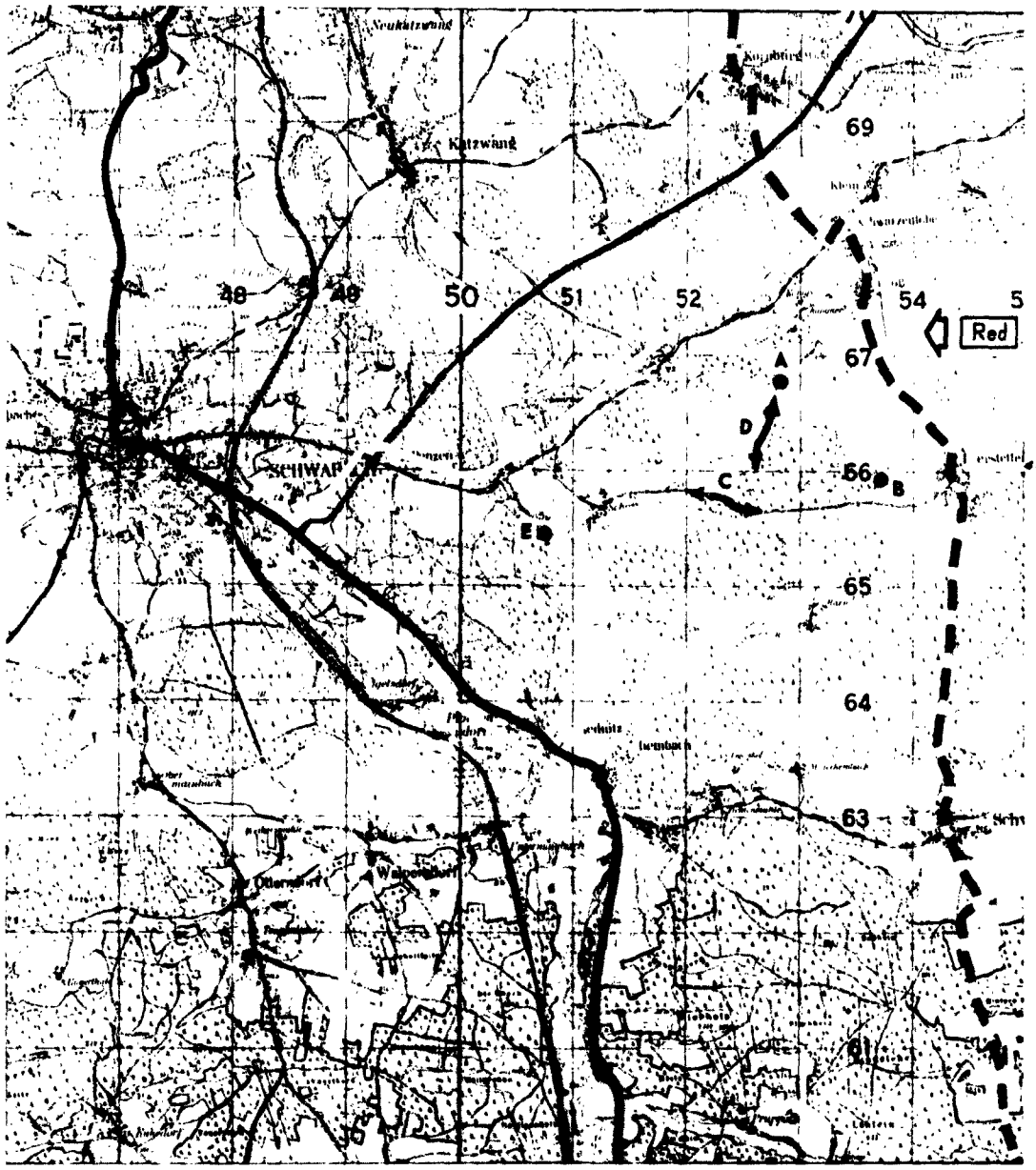


Fig. 1—Blue Target Complex, Day 1

Blue phase lines: ———, RETREAT; — —, OLDPOSE

White line, Red reconnaissance area

Elements: A, Tank; B, Jeep; C, Moving APC; D, Moving jeep; E, Infantry machinegun position

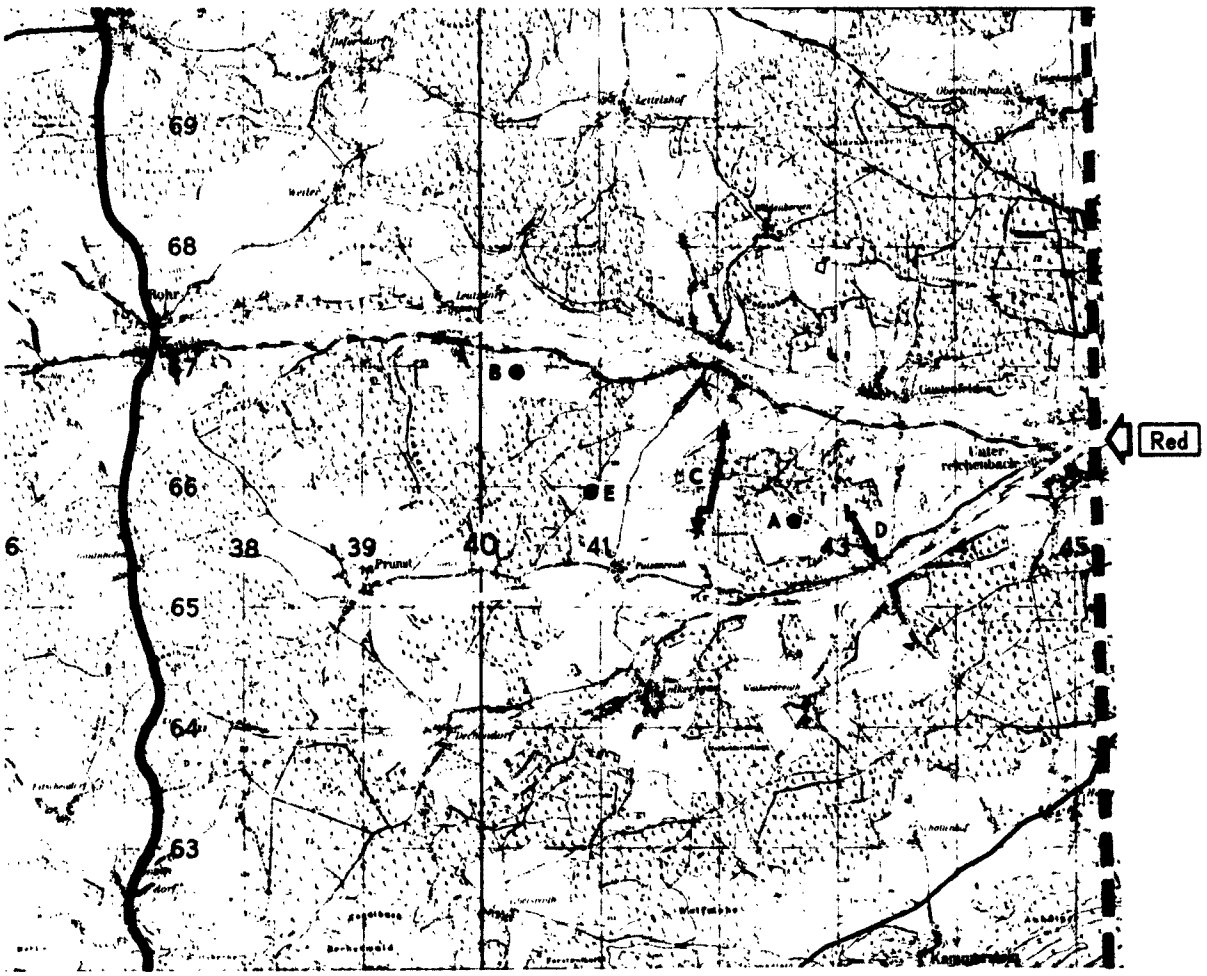


Fig. 2—Blue Target Complex, Day 2

Blue phase lines: ———, REDHEADS; — —. BLUEBOYS

White line, Red reconnaissance area

Elements: A, Tank; B, Jeep; C, Moving APC; D, Moving jeep; E, Infantry machinegun position

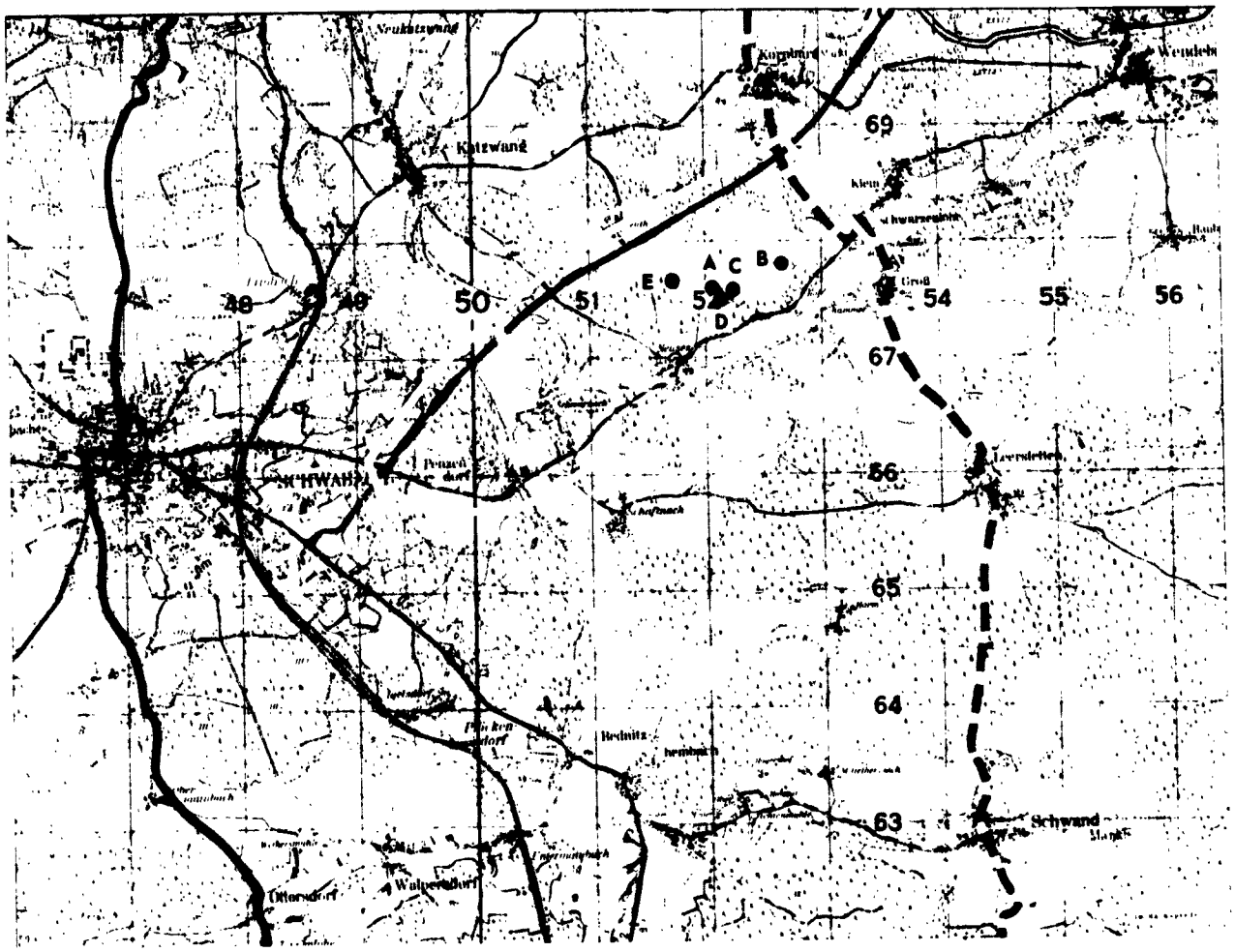


Fig. 3—Blue Target Complex, Day 3

Phase lines: ———, RED; — — —, BLUE

White line, Red reconnaissance area

Elements: A, Tank; B, Jeep; C, APC; D, Mortar APC; E, Jeep

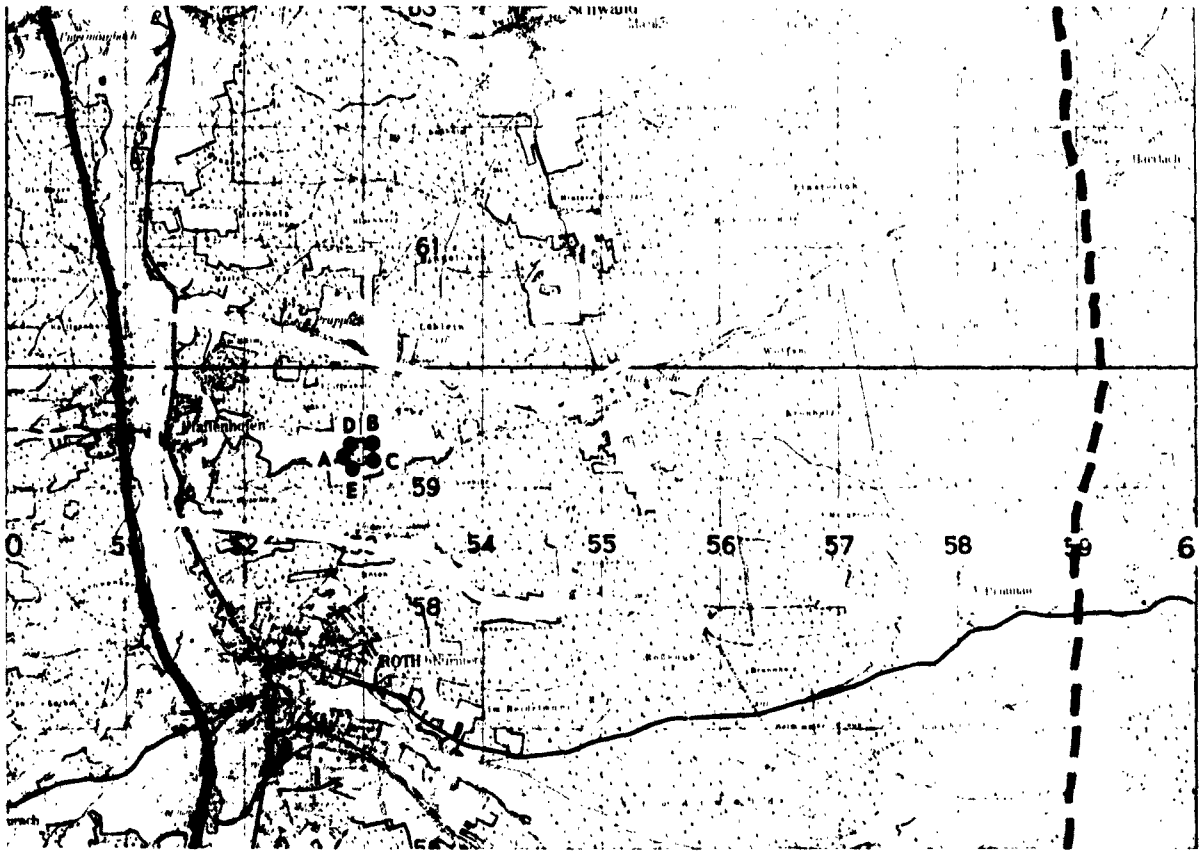


Fig. 4—Blue Target Complex, Day 4

Phase lines: ———, RED; — —, BLUE

White line, Red reconnaissance area

Elements: A, Tank; B, Jeep; C, Infantry machinegun position; D, APC; E, Jeep

Fig. 5—Blue Target Complex, Day 5

Phase lines: ———, RED; — —, BLUE

White line, Red reconnaissance area

Elements: A, Moving APC; B, Moving APC; C, Moving APC (run 5-2 only); D, Moving jeep; E, Moving jeep

The intelligence information of the Red army narrowed the location of the task force to the region between the Finster Bach and the Brunn Bach east of the Rednitz River, and helicopters were sent out to pinpoint the location of the enemy within the 9-km^2 area defined in Fig. 4.

(5) A scout platoon of Blue forces alternately advanced and withdrew along the 2-km north-south road from Kottensdorf to Putzenreuth. Two jeeps were on the left and right flanks of the armored column to secure the wooded areas on their respective sides. Red forces sent helicopters to perform a screening mission over the 10-km^2 area defined in Fig. 5.

The helicopters employed singly and in pairs were instructed to fly one of the three tactics under consideration and were free to choose their path(s) of flight, speed of reconnaissance, and points of dismount and pop-up.

During the 5 days 27 runs using 40 helicopters were made as indicated in Table 1.

EXPERIMENTAL PROCEDURE

This section provides details concerning experimental procedures including a discussion of experimental layout, types of data collected, and methods by which the data were obtained.

The scenarios were designed to be as realistic as possible within the constraints necessary to maintain safety and control. Such factors as conducting the experiment away from familiar training areas with the inherent problems of logistics, maneuver damage, and harassment of and from the local population; operating with a manageable number of air and ground elements; and the limited number of analysts and technicians available influenced the magnitude of the experiment.

GROUND ROLE

The ground elements were tactically located with consideration of ground as well as air threat as indicated in parts a to f of Fig. 6. A detailed description of target positions can be found in App F. Key tactical terrain features and logical avenues of enemy infiltration and advance were of primary concern in the positioning of the ground elements. Military advice governed the positioning of the ground elements with respect to tactical realism. Although it soon became apparent to the crews of the ground complex that the only enemy in the problem consisted of helicopters, the possibility of being located by a dismounted observer prevented complete concentration of attention on the aerial forces.

On acquiring an enemy helicopter or helicopters or a dismounted ground observer, the acquirer reported the following information to ground control over the assigned ground-radio frequency: his own designation, objects acquired, and the repeated designation, e.g., "Alpha, two helicopters, Alpha."

If the ground element was then also able to lay its weapon on a helicopter and fire, the following sequence was reported: target designation, fire, target designation, e.g., "Alpha, fire, Alpha." The gunners were instructed to aim directly at the center of mass of the helicopter when simulating fire. The accuracy of the aim of the weapon was determined by the use of gun cameras.

Ground targets included M48A2 tanks, M113 APCs, M151 jeeps, and machinegun squads. The air defense capabilities of these elements are a .50-cal machinegun, cupola mounted; .50-cal machinegun, pedestal mounted; 7.62-mm machinegun, pedestal mounted; and 7.62-mm machinegun, bipod-mounted, respectively.

a

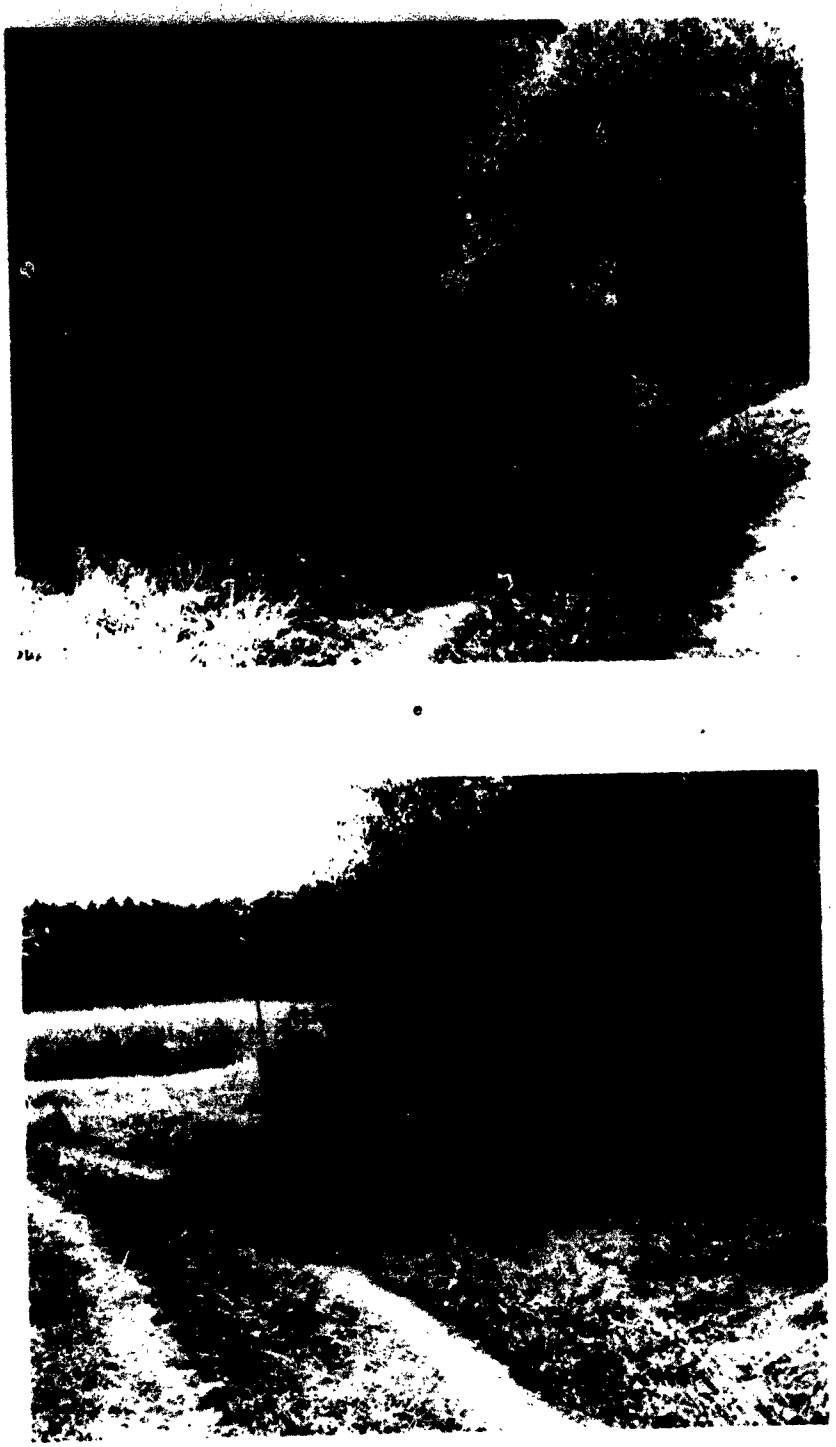
b

Fig. 6—Typical Positioning of Ground Elements

c

d

Fig. 6 (Continued)



f

Fig. 6 (Continued)

All pilots and crew chiefs involved in the experiment were assigned to Delta Trp (Air Cav), 2d Recon Sqdn, 15th Cav, 4th Armd Div (later redesignated 2d Sqdn, 4th Cav). This troop was organized in June 1962, the first unit of its kind in the Seventh Army. This experiment was conducted after the troop had had an opportunity to complete the normal new organizational shakedown and had finished one complete cycle of training including live firing. In addition the troop had experienced negligible personnel turnover. Consequently the pilots had mastered the difficult technique of nap-of-the-earth flying, while being afforded the chance to perform their mission under a variety of environmental conditions.

The two-place Bell OH-13 helicopter, the vehicle currently used by the light scout section of the air cavalry troop, was used for all runs and carries a pilot and a crew chief who doubles as an observer.

In all, 19 different pilots—11 captains, 3 lieutenants, and 5 warrant officers—participated in the 27 runs (40 flights including those flying in teams). The pilots had an average of 485 hr experience in rotary-wing aircraft. No crew flew against the same ground complex more than once.

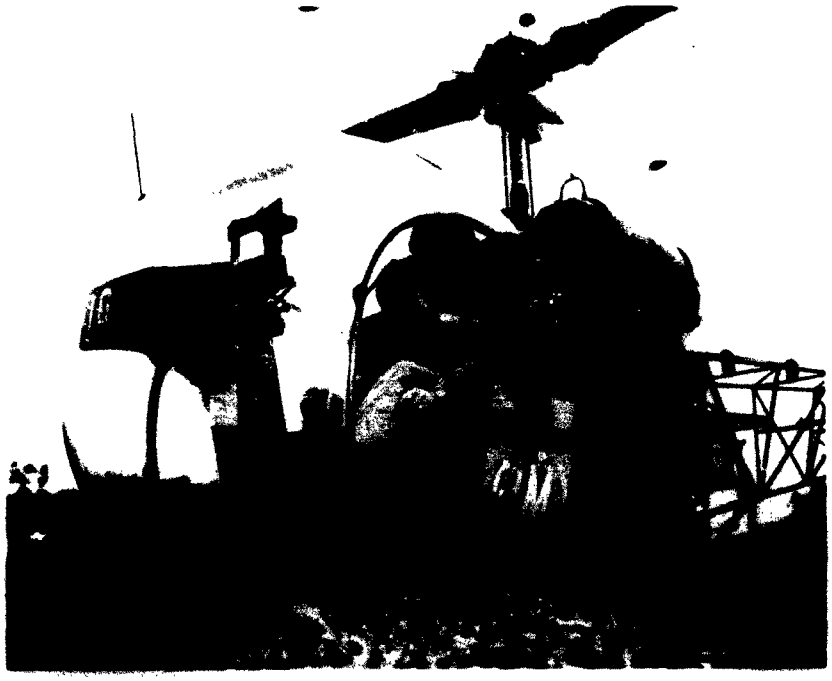


Fig. 7—Air Control Briefing of OH-13 Helicopter Pilot before a Run

Before each run the pilot(s) and crew chief(s) were given a briefing that included definition of the problem, location of enemy and friendly territories, their area of responsibility, and a general description of the suspected enemy in that area, such as "intelligence reports indicate that a scout platoon is acting as a delaying force in the area" (see Fig. 7). They then were required to per-

form their mission constrained only by the tactic of flight, i.e., high, low, or low with dismount and/or pop-up. The path of flight, positions of pop-up or dismount, speed of reconnaissance, and consequent length of mission were all left to the crew's discretion.

On acquiring an enemy ground element the pilot reported the following information to ground control over the assigned air-radio frequency: helicopter designation, element acquired, repeat helicopter designation, e.g., "helicopter B, one moving jeep, helicopter B." The helicopters were instructed to perform an evasive action after locating the ground element; they were instructed not to simulate fire, even against the jeep and infantry positions.

On completion of his mission the pilot reported to ground control and flew to his air control site, where he was required to trace his flight path on a large-scale (1:25,000) map of the area indicating locations of the elements of the ground complex acquired and the point along the flight path at which the acquisition occurred.

GUN CAMERAS AND MOUNTS

Gun cameras type AN-N6, 16-mm, using 50-ft magazines, were mounted at each gun position. The cameras were activated by depression of the weapon's trigger and remained running as long as the trigger was depressed.

Mounts were designed and constructed for the purpose of attaching and aligning the camera's optical axis with the associated weapon. With the exception of the M48 tank's cupola-mounted machinegun, the mounts were designed to avoid any change in the handling characteristics of the weapons (see Figs. 8 to 10). A counterweight was used to offset the weight of the camera on the M48 tank's cupola-mounted machinegun as shown in Fig. 11.

Film-loading and lens-setting operations were performed by ground technicians prior to each run. Alignment of the camera's optical axis with that of its companion weapon was performed during installation and was rechecked periodically.

In all cases "zeroing" pictures were taken before the runs at each gun-camera position to establish the aiming point of each gun in the film frames. Each run was identified by photographing a board showing run number and crew.

COLLECTION OF TIME DATA

A standard pen recorder was operated at ground control to obtain the necessary time information. Two radios, one on the established ground frequency and the second on the air frequency, were also located at ground control (see Fig. 12). In response to an announcement of a helicopter sighting by a ground element, the pen corresponding to the sighter would be activated, causing an input to appear on that element's pen line. The same technique was used for recording firings by ground forces and helicopter sightings of ground elements.

Nine pens were used for data collection. A pen for each of the five ground positions was activated by depressing the corresponding switch on the ground-

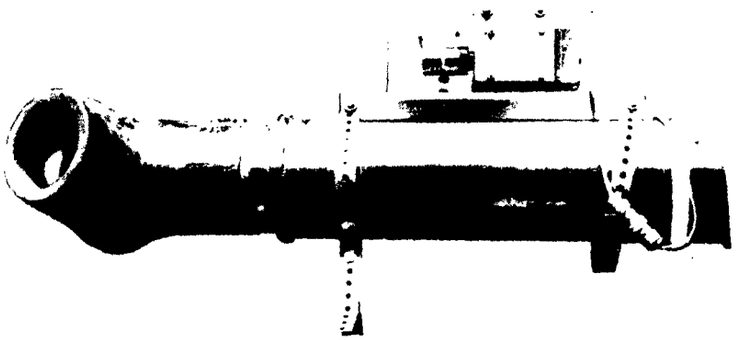


Fig. 8—M48 Tank Main-Gun Camera Mount

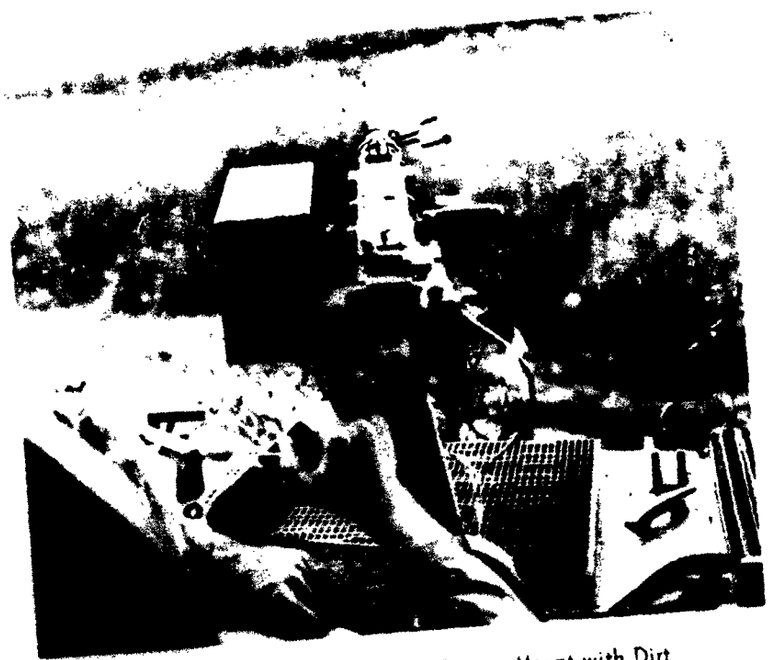


Fig. 9—APC M2 Machinegun Camera Mount with Dirt and Dust Cover Closed

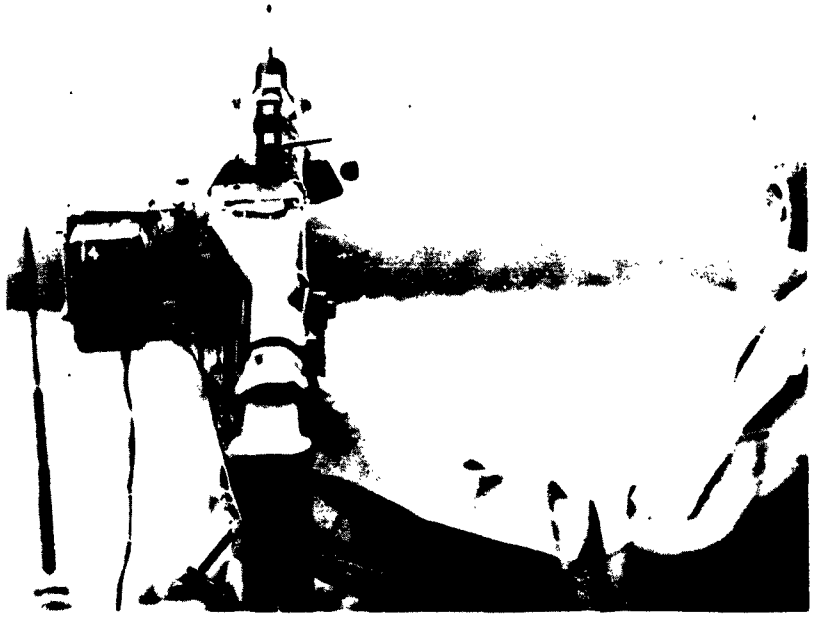


Fig. 10—M60 Machinegun Camera Mount

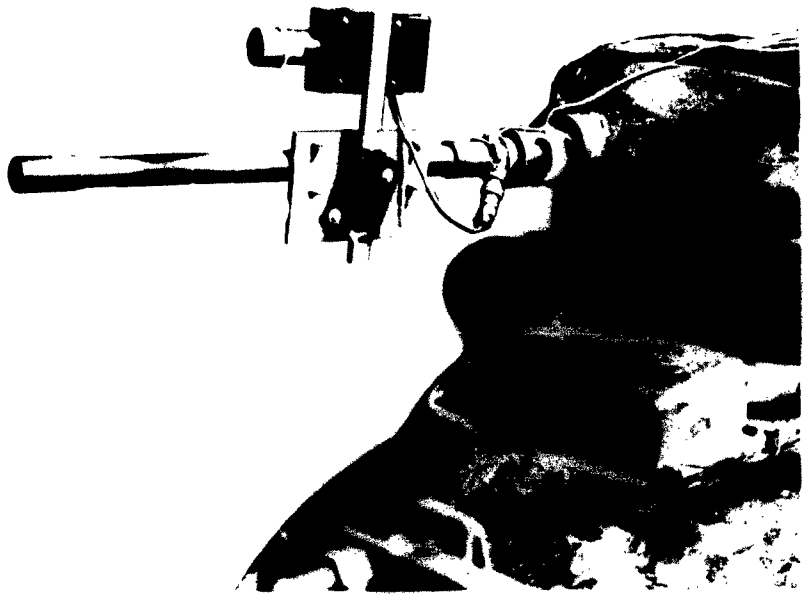


Fig. 11—M48 Tank Cupola-Mounted Machinegun Camera

element box. A sixth pen was automatically activated by the firing of a 90-mm flash-bang simulator (simulating tank and mortar fire) on the first 3 days. A seventh pen was connected to a timing device and automatically indicated 4-sec intervals. The remaining two pens corresponding to the reconnaissance helicopters were activated by depression of the appropriate switches on the air-element box.

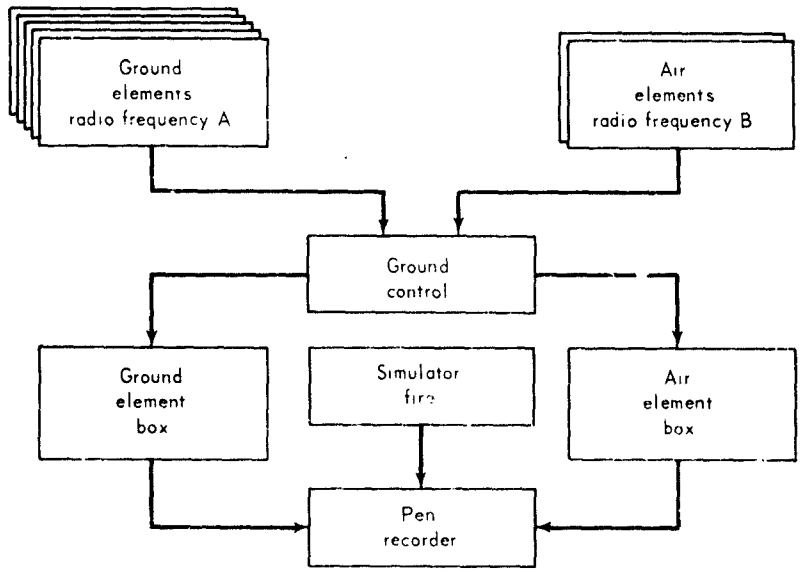


Fig. 12—Schematic of Time-Recording Sequence

RECONSTRUCTION OF FLIGHT PATHS

RAC analysts with detailed maps of the area were positioned at each gun location. On locating a helicopter the location and flight path of the aircraft were traced on a map by the analyst. At the conclusion of a run he interrogated the ground crew to determine the points on his flight-path traces at which the helicopter was sighted and fired on.

The helicopter crews were required to trace their flight path and pinpoint the location of ground elements acquired after each run.

By comparing the information obtained independently from the air and ground participants it was possible to reconstruct the position of event occurrence. Combining this with the pen-recorded data allowed the reconstruction of events as to both time and place. These results are presented in App C.

REALISM

Simulated Gunfire

Simulated gunfire was used to heighten tactical realism of the scenarios. For the first 2 days of runs a 90-mm flash-bang simulator located in front of

the M48 tank was detonated whenever the trigger of the main gun was depressed. On the third day the simulators were manually activated in front of the APC mortar on command from ground control. No simulators were used on the last 2 days of runs, since they had no bearing on the tactical situation. On the days in which an infantry position was a part of the ground complex 7.62-mm machinegun blank ammunition was fired from one of the two machineguns positioned at the infantry site. Film data were obtained from the second machinegun.

Combat Noise

During the experiment, ground elements were subjected to simulated battlefield noise. This masking noise was accomplished during selected runs on Days 2 to 4 using a composite battle-sound tape.

All vehicles were required to keep their engines running during the conduct of the experiment. All personnel were instructed to wear their steel helmets.

DATA ANALYSIS

DISCUSSION

Two approaches were used in the analysis of the experimental data. Statistical techniques were used to compare factors influencing the time and sighting data collected. The film data were analyzed to measure the effectiveness of ground fire and to estimate survivability of the aircraft. These two approaches are treated independently and are presented in the two sections that follow.

Several observations concerning the data should be made.

When conducting a field experiment of this type, especially with personnel from a tactical unit, certain trade-offs between rigorous experimental design and maintenance of tactical reality are required. The success of such an undertaking depends largely on the cooperation of the US Army and the particular units involved and on the availability of human and material resources. The conduct of the experiment should provide training benefits wherever possible.

Several observations regarding tactics are pertinent. The experiment was performed in the summer, hence the effects of less foliage, snow, overcast sky, reaction to cold—to name a few—are not known. Actual meteorological conditions prevailing during the conduct of the experiment are presented in App E. An experiment comparing helicopter reconnaissance techniques in a winter environment was conducted in January 1964 by the authors of this memorandum, and the results should be available by August 1964.

The direct applicability of the results to a different ground complex, e.g., one that differs in size and composition, is uncertain.

The measurements made of the several reconnaissance techniques investigated would undoubtedly be affected if the ground elements had been subjected to hostile ground elements.

Helicopters were not subjected to hostile air attack, but similar effects would doubtless have occurred in the measurements if this had been included in the experiment.

ANALYSIS OF ACQUISITION DATA

Introduction

Statistical techniques were used to analyze the two-sided acquisition data recorded by ground control. In these analyses emphasis was placed on comparing the effects of (a) flying high vs low vs low with dismount and/or pop-up;

TABLE 2

Summary of Experimental Conditions for 27 Runs

Run	Helicopters used	Flight technique	Target complex	Ground elements						
				Tank	Jeep	Moving jeep	APC	Moving APC	Infantry	Total
1-1	1	High	Dispersed	1	—	1	—	1	1	4
1-2	2	Low	Dispersed	1	—	1	—	1	1	4
1-3	2	High	Dispersed	1	1	1	—	1	1	5
1-4	2	Low	Dispersed	1	1	1	—	1	1	5
2-1	1	High	Dispersed	1	1	1	—	1	1	5
2-2	2	Low	Dispersed	1	1	1	—	1	1	5
2-3	1	Low	Dispersed	1	1	1	—	1	1	5
2-4	1	High	Dispersed	1	1	1	—	1	1	5
2-5	1	Low	Dispersed	1	1	1	—	1	1	5
2-6	2	High	Dispersed	1	1	1	—	1	1	5
3-1	1	Low	Concentrated	1	2	—	2	—	—	5
3-2	2	Low, dismount and/or pop-up	Concentrated	1	2	—	2	—	—	5
3-3	1	Low	Concentrated	1	2	—	2	—	—	5
3-4	2	Low, dismount and/or pop-up	Concentrated	1	2	—	2	—	—	5
3-5	1	High	Concentrated	1	2	—	2	—	—	5
3-6	2	Low, dismount and/or pop-up	Concentrated	1	2	—	2	—	—	5
4-1	1	High	Concentrated	1	2	—	1	—	1	5
4-2	2	Low, dismount and/or pop-up	Concentrated	1	2	—	1	—	1	5
4-3	1	Low, dismount and/or pop-up	Concentrated	1	2	—	1	—	1	5
4-4	2	Low, dismount and/or pop-up	Concentrated	1	2	—	1	—	1	5
4-5	2	High	Concentrated	1	2	—	1	—	1	5
4-6	1	High	Concentrated	1	2	—	1	—	1	5
5-1	1	Low, dismount and/or pop-up	Moving	—	—	2	—	2	—	4
5-2	2	Low	Moving	—	—	2	—	3	—	5
5-3	1	Low, dismount and/or pop-up	Moving	—	—	2	—	2	—	4
5-4	1	Low, dismount and/or pop-up	Concentrated	—	2	—	2	—	—	4
5-5	2	Low, dismount and/or pop-up	Moving	—	—	2	—	2	—	4
Total				22	34	18	20	19	16	129

(b) reconnoitering against moving vs stationary dispersed vs stationary concentrated ground units; (c) reconnoitering against target complexes that included various mixes of tanks, APCs, jeeps, and infantry; and (d) employing helicopters singly vs in pairs. Experimental conditions for the 27 runs conducted are summarized in Table 2.

In studying the effects of varying these experimental conditions, the following primary measures of acquisition effectiveness were utilized: (a) the number

TABLE 3

Acquisition Advantages

Run	Advantages scored by these elements							Advantages scored against these elements						
	Tank	Jeep	Moving jeep	APC	Moving APC	Inf	Total	Tank	Jeep	Moving jeep	APC	Moving APC	Inf	Total
One-sided acquisition														
1-1	3	—	0	—	0	1	4	0	—	0	—	0	0	0
1-2	0	—	2	—	0	1	3	0	—	0	—	0	0	0
1-3	2	4	2	—	0	3	11	0	1	0	—	0	0	1
1-4	2	0	2	—	1	3	8	1	0	0	—	0	0	1
2-1	1	1	1	—	1	3	7	1	0	0	—	0	0	1
2-2	0	2	3	—	0	6	11	0	0	0	—	0	0	0
2-3	1	1	1	—	0	1	4	0	0	0	—	0	0	0
2-4	0	1	0	—	1	1	3	0	0	1	—	0	0	1
2-5	0	2	1	—	0	0	3	0	0	1	—	1	0	2
2-6	2	2	4	—	0	1	9	0	0	0	—	0	0	0
3-1	0	0	—	3	—	—	3	0	0	—	0	—	—	0
3-2	1	1	—	1	—	—	3	1	1	—	0	—	—	2
3-3	0	3	—	4	—	—	7	0	0	—	0	—	—	0
3-4	0	6	—	2	—	—	8	1	0	—	0	—	—	1
3-5	3	4	—	4	—	—	11	0	0	—	0	—	—	0
3-6	2	2	—	1	—	—	5	0	1	—	0	—	—	1
4-1	0	1	—	0	—	1	2	0	0	—	0	—	0	0
4-2	0	0	—	0	—	0	0	1	0	—	1	—	1	3
4-3	0	2	—	0	—	1	3	0	0	—	1	—	0	1
4-4	1	1	—	0	—	0	2	1	1	—	0	—	1	3
4-5	1	4	—	0	—	3	8	0	0	—	1	—	0	1
4-6	0	3	—	0	—	2	5	0	0	—	0	—	0	0
5-1	—	—	0	—	0	—	0	—	—	0	—	2	—	2
5-2	—	—	1	—	1	—	2	—	—	0	—	0	—	0
5-3	—	—	2	—	0	—	2	—	—	0	—	1	—	1
5-4	—	2	—	2	—	—	4	—	0	—	2	—	—	2
5-5	—	—	0	—	0	—	0	—	—	0	—	2	—	2
Subtotal	19	42	19	17	4	27	128	6	4	2	5	6	2	25
Interacquisition														
1-1	0	—	1	—	0	0	1	0	—	0	—	1	0	1
1-2	1	—	1	—	1	0	3	0	—	0	—	0	0	0
1-3	1	0	0	—	0	0	1	0	0	0	—	1	0	1
1-4	0	0	0	—	0	0	0	0	0	0	—	0	0	0
2-1	0	1	0	—	0	1	2	0	0	0	—	0	0	0
2-2	1	0	0	—	1	0	2	0	1	0	—	0	0	1
2-3	1	0	0	—	0	1	2	0	0	0	—	0	0	0
2-4	1	0	0	—	0	0	1	0	0	0	—	0	0	0
2-5	1	0	0	—	0	1	2	0	0	0	—	0	0	0
2-6	1	0	0	—	0	1	2	0	0	0	—	1	1	2
3-1	1	1	—	0	—	—	2	0	0	—	0	—	—	0
3-2	0	1	—	0	—	—	1	0	0	—	0	—	—	0
3-3	1	1	—	0	—	—	2	0	0	—	0	—	—	0

TABLE 3 (Continued)

Run	Advantages scored by these elements							Advantages scored against these elements						
	Tank	Jeep	Moving jeep	APC	Moving APC	Inf	Total	Tank	Jeep	Moving jeep	APC	Moving APC	Inf	Total
3-4	0	0	—	0	—	—	0	0	0	—	1	—	—	1
3-5	0	1	—	0	—	—	1	0	0	—	0	—	—	0
3-6	0	0	—	2	—	—	2	1	0	—	1	—	—	2
4-1	0	0	—	0	—	0	0	0	0	—	1	—	0	1
4-2	0	0	—	0	—	0	0	0	0	—	0	—	0	0
4-3	0	0	—	0	—	0	0	0	0	—	0	—	0	0
4-4	0	0	—	0	—	0	0	0	0	—	0	—	0	0
4-5	1	0	—	0	—	0	1	0	0	—	0	—	0	0
4-6	1	1	—	0	—	0	2	0	0	—	1	—	0	1
5-1	—	—	0	—	0	—	0	—	—	1	—	0	—	1
5-2	—	—	0	—	1	—	1	—	—	0	—	1	—	1
5-3	—	—	0	—	0	—	0	—	—	0	—	0	—	0
5-4	—	0	—	0	—	—	0	—	0	—	0	—	—	0
5-5	—	—	0	—	0	—	0	—	—	0	—	0	—	0
Subtotal	11	6	2	2	3	4	28	1	1	1	4	4	1	12
Overall Acquisition														
1-1	3	—	1	—	0	1	5	0	—	0	—	1	0	1
1-2	1	—	3	—	1	1	6	0	—	0	—	0	0	0
1-3	3	4	2	—	0	3	12	0	1	0	—	1	0	2
1-4	2	0	2	—	1	3	8	1	0	0	—	0	0	1
2-1	1	2	1	—	1	4	9	1	0	0	—	0	0	1
2-2	1	2	3	—	1	6	13	0	1	0	—	0	0	1
2-3	2	1	1	—	0	2	6	0	0	0	—	0	0	0
2-4	1	1	0	—	1	1	4	0	0	1	—	0	0	1
2-5	1	2	1	—	0	1	5	0	0	1	—	1	0	2
2-6	3	2	4	—	0	2	11	0	0	0	—	1	1	2
3-1	1	1	—	3	—	—	5	0	0	—	0	—	—	0
3-2	1	2	—	1	—	—	4	1	1	—	0	—	—	2
3-3	1	4	—	4	—	—	9	0	0	—	0	—	—	0
3-4	0	6	—	2	—	—	8	1	0	—	1	—	—	2
3-5	3	5	—	4	—	—	12	0	0	—	0	—	—	0
3-6	2	2	—	3	—	—	7	1	1	—	1	—	—	3
4-1	0	1	—	0	—	1	2	0	0	—	1	—	0	1
4-2	0	0	—	0	—	0	0	1	0	—	1	—	1	3
4-3	0	2	—	0	—	1	3	0	0	—	1	—	0	1
4-4	1	1	—	0	—	0	2	1	1	—	0	—	1	3
4-5	2	4	—	0	—	3	9	0	0	—	1	—	0	1
4-6	1	4	—	0	—	2	7	0	0	—	1	—	0	1
5-1	—	—	0	—	0	—	0	—	—	1	—	2	—	3
5-2	—	—	1	—	2	—	3	—	—	0	—	1	—	1
5-3	—	—	2	—	0	—	2	—	—	0	—	1	—	1
5-4	—	2	—	2	—	—	4	—	0	—	2	—	—	2
5-5	—	—	0	—	0	—	0	—	—	0	—	2	—	2
Total	30	48	21	19	7	31	156	7	5	3	9	10	3	37

of one-sided acquisition advantages, i.e., those instances in which one side saw the other and was not seen in return; (b) the number of interacquisition advantages, i.e., those instances in which one side saw the other but was later seen in return; (c) the total number of overall acquisition advantages, i.e., the total number of times one side saw the other first; and (d) the number of targets

TABLE 4

Ground Targets Acquired Compared with Ground Targets Available

Run	Targets acquired							Targets available						
	Tank	Jeep	Moving jeep	APC	Moving APC	Inf	Total	Tank	Jeep	Moving jeep	APC	Moving APC	Inf	Total
1-1	0	—	1	—	1	0	2	1	—	1	—	1	1	4
1-2	1	—	1	—	1	0	3	1	—	1	—	1	1	4
1-3	1	1	0	—	1	0	3	1	1	1	—	1	1	5
1-4	1	0	0	—	0	0	1	1	1	1	—	1	1	5
2-1	1	1	0	—	0	1	3	1	1	1	—		1	5
2-2	1	1	0	—	1	0	?	1	1	1	—	1	1	5
2-3	1	0	0	—	0	1	2	1	1	1	—	1	1	5
2-4	1	0	1	—	0	0	2	1	1	1	—	1	1	5
2-5	1	0	1	—	1	1	4	1	1	1	—	1	1	5
2-6	1	0	0	—	1	1	3	1	1	1	—	1	1	5
3-1	1	1	—	0	—	—	2	1	2	—	2	—	—	5
3-2	1	1	—	0	—	—	2	1	2	—	2	—	—	5
3-3	1	1	—	0	—	—	2	1	2	—	2	—	—	5
3-4	1	0	—	1	—	—	2	1	2	—	2	—	—	5
3-5	0	1	—	0	—	—	1	1	2	—	2	—	—	5
3-6	1	1	—	2	—	—	4	1	2	—	2	—	—	5
4-1	1	0	—	1	—	0	2	1	2	—	1	—	1	5
4-2	1	0	—	1	—	1	3	1	2	—	1	—	1	5
4-3	0	0	—	1	—	0	1	1	2	—	1	—	1	5
4-4	1	1	—	0	—	1	3	1	2	—	1	—	1	5
4-5	1	0	—	1	—	—	2	1	2	—	1	—	1	5
4-6	1	1	—	1	—	0	3	1	2	—	1	—	1	5
5-1	—	—	1	—	2	—	3	—	—	2	—	2	—	4
5-2	—	—	0	—	2	—	2	—	—	2	—	3	—	5
5-3	—	—	0	—	1	—	1	—	—	2	—	2	—	4
5-4	—	0	—	2	—	—	2	—	2	—	2	—	—	4
5-5	—	—	0	—	2	—	2	—	—	2	—	2	—	4
Total	19	10	5	10	13	6	63	22	34	18	20	19	16	129

acquired compared with available targets. Data covering these measures are shown in Tables 3 to 5. A more detailed discussion of these measures of effectiveness has been presented in App A.

Comparison of Acquisition Advantages

When the performance of helicopters and ground elements was compared, it was found that ground elements were far more effective in acquiring helicop-

ters than helicopters were in acquiring ground elements. In Table 6, for example, it can be seen that ground elements saw helicopters first in 156 of 193 sightings, or over 80 percent of the time. The average length of interacquisition advantages recorded by ground elements was 12 sec, compared with only 6 sec for helicopters (see App A, Tables A145, A146).

TABLE 5

Helicopters Acquired Compared with Helicopters Available

Run	Helicopters acquired by these elements							Helicopters available to these elements						
	Tank	Jeep	Moving jeep	APC	Moving APC	Inf	Total	Tank	Jeep	Moving jeep	APC	Moving APC	Inf	Total
1-1	1	—	1	—	1	1	4	1	—	1	—	1	1	4
1-2	2	—	2	—	1	1	6	2	—	2	—	2	2	8
1-3	1	2	1	—	2	2	8	2	2	2	—	2	2	10
1-4	2	0	2	—	1	2	7	2	2	2	—	2	2	10
2-1	1	1	1	—	1	1	5	1	1	1	—	1	1	5
2-2	2	2	2	—	2	2	10	2	2	2	—	2	2	10
2-3	1	1	1	—	0	1	4	1	1	1	—	1	1	5
2-4	1	1	1	—	1	1	5	1	1	1	—	1	1	5
2-5	1	1	1	—	1	1	5	1	1	1	—	1	1	5
2-6	2	1	2	—	2	2	9	2	2	2	—	2	2	10
3-1	1	1	—	2	—	—	4	1	2	—	2	—	—	5
3-2	1	3	—	1	—	—	5	2	4	—	4	—	—	10
3-3	1	2	—	2	—	—	5	1	2	—	2	—	—	5
3-4	1	4	—	3	—	—	8	2	4	—	4	—	—	10
3-5	1	2	—	2	—	—	5	1	2	—	2	—	—	5
3-6	2	4	—	3	—	—	9	2	4	—	4	—	—	10
4-1	1	1	—	1	—	1	4	1	2	—	1	—	1	5
4-2	1	0	—	0	—	0	1	2	4	—	2	—	2	10
4-3	0	2	—	0	—	1	3	1	2	—	1	—	1	5
4-4	1	1	—	0	—	0	2	2	4	—	2	—	2	10
4-5	2	3	—	2	—	2	9	2	4	—	2	—	2	10
4-6	1	2	—	1	—	1	5	1	2	—	1	—	1	5
5-1	—	—	1	—	0	—	1	—	—	2	—	2	—	4
5-2	—	—	1	—	3	—	4	—	—	4	—	6	—	10
5-3	—	—	1	—	1	—	2	—	—	2	—	2	—	4
5-4	—	2	—	2	—	—	4	—	2	—	2	—	—	4
5-5	—	—	0	—	0	—	0	—	—	4	—	4	—	8
Total	27	36	17	19	16	19	134	33	50	27	29	29	24	192

The detailed data underlying those summarized in Table 6 were analyzed using statistical techniques. The results of chi-square and *t* tests are presented in App A. Major findings based on acquisition advantages are summarized below:

(a) Ground elements recorded significantly more acquisition advantages than helicopters.

(b) Flying in pairs did not appear to increase the acquisition effectiveness of the helicopters.

(c) Helicopters employing the low with dismount and/or pop-up tactic were more effective than helicopters using the reconnaissance tactics of flying high or nap of the earth.

TABLE 6

Summary of Air Acquisition Advantages Compared with Ground Acquisition Advantages for 27 Runs

Type of advantage	Helicopter advantages	Ground advantages	Total
One-sided acquisition	25	128	153
Interacquisition	12	28	40
Overall acquisition	37	156	193

(d) Ground elements in the simulated armor column were less effective in acquiring helicopters than ground elements in dispersed or concentrated employments.

(e) In terms of overall acquisition advantages the smaller ground elements (jeeps, infantry) were more effective in acquiring helicopters than the larger elements (tanks, APCs); the stationary elements, more than moving elements.

(f) Supplementary analyses investigating the performance of helicopters against dispersed and concentrated employments only led to conclusions similar to those of items a to c.

Air Effectiveness Compared with Ground Effectiveness in Acquiring Available Targets

Comparisons were also made on the basis of available targets acquired. From Table 7 it can be seen that approximately 70 percent of the available helicopters were acquired compared with 49 percent of the available ground

TABLE 7

Summary of Air Effectiveness Compared with Ground Effectiveness in Acquiring Available Targets for 27 Runs

Type of target	Targets acquired	Targets available	Percent acquired
Helicopter	134	192	70
Ground element	63	129	49

elements. The results of this analysis, presented in detail in App A, are summarized below:

(a) Ground elements saw fewer helicopters when the low with dismount and/or pop-up tactic was used than when other reconnaissance tactics were used. A total of 54 of 59 available helicopters flying high were seen, 45 of 58 flying low, but only 35 of 75 employing the dismount and pop-up tactics.

TABLE 8

Comparison of Acquisition Advantages

Type	Possessor	Helicopters used		Comparisons of reconnaissance tactics						Comparisons of target complexes					
		One	Two	High	Low	High	Low, dismount and or pop-up	Low	Low, dismount and or pop-up	Moving	Dispersed	Moving	Concentrated	Dispersed	Concentrated
		Mean advantages per run													
One-sided acquisition	Ground	4.1	5.4	6.7	5.1	6.7	2.7	5.1	2.7	1.0	6.3	1.0	4.7	6.3	4.7
	Air	0.7	1.2	0.4	0.3	0.4	1.8	0.3	1.8	1.3	0.6	1.3	1.1	0.6	1.1
Interacquisition	Ground	1.1	1.0	1.2	1.8	1.2	0.3	1.8	0.3	0.3	1.6	0.3	0.8	1.6	0.8
	Air	0.3	0.6	0.7	0.3	0.7	0.4	0.3	0.4	0.5	0.5	0.5	0.4	0.5	0.4
Overall acquisition	Ground	5.2	6.4	7.9	6.9	7.9	3.0	6.9	3.0	1.3	7.9	1.3	5.5	7.9	5.5
	Air	1.0	1.8	1.1	0.6	1.1	2.2	0.6	2.2	1.8	1.1	1.8	1.5	1.1	1.5

(b) In terms of the number of available ground targets acquired by helicopters, however, the low with dismount and/or pop-up tactic was no more effective than the high or nap-of-the-earth tactics. For each of the three tactics approximately 50 percent of the available ground elements were acquired.

(c) More helicopters were detected with dispersed (87 percent) and concentrated (68 percent) employments than with the moving column (27 percent).

TABLE 9

Summary of Statistical Analyses

(Probability that observed differences could have happened by chance)

Experimental conditions	Type of advantage possessed						Targets acquired vs targets available	
	One-sided acquisition		Interacquisition		Overall acquisition			
	Ground	Air	Ground	Air	Ground	Air	Ground	Air
	Probability							
Helicopters used, 1 vs 2	0.30	0.30	0.80	0.20	0.40	0.05	0.10	0.50
Flight technique								
High vs low	0.40	0.80	0.20	0.20	0.50	0.20	0.50	0.95
High vs low, dismount and or pop-up	0.001	0.001	0.01	0.50	0.01	0.01	0.01	0.80
Low vs low, dismount and or pop-up	0.10	0.001	0.01	0.60	0.02	0.001	0.05	0.90
High, low vs low, dismount and or pop-up	0.02	0.001	0.001	0.70	0.01	0.001	0.01	0.80
Target complex								
Moving vs dispersed	0.01	0.20	0.02	—	0.01	0.20	0.01	0.70
Moving vs concentrated	0.02	0.70	0.30	0.70	0.05	0.60	0.02	0.90
Dispersed vs concentrated	0.30	0.30	0.10	0.60	0.20	0.40	0.20	0.50
Moving vs dispersed, concentrated	0.02	0.50	0.10	0.80	0.01	0.50	0.01	0.90
Between elements	0.01	0.50	0.10	0.20	0.001	0.10	0.80	0.05
Moving vs stationary	0.05	0.70	0.30	0.50	0.01	0.50	0.30	0.98
Large vs small	0.001	0.05	0.30	0.10	0.01	0.01	0.70	0.01
Vehicle X vs others	—	—	—	0.01 (APC)	0.001 (APC) 0.01 (Inf)	0.01 (APC)	—	0.01 (Tank)

(d) The different types of ground elements (tanks, APCs, jeeps, infantry) did not vary significantly in their ability to acquire available helicopters.

(e) On the other hand, helicopters acquired some types of ground elements more readily than others; e.g., jeeps and infantry were detected less frequently than the larger ground targets.

Details of the acquisition analyses mentioned in this section of the report are provided in App A. Summaries of the statistical comparisons in App A are presented in Tables 8 and 9.

Time to Complete Mission

Analyses of the length of time required for helicopters to complete a mission with each of the three reconnaissance techniques were also made. It was found that an average of 10.5 min was required to complete the 9 runs flying high, an average of 21.5 min for the 8 runs flying low, and an average of 35.5 min for the 10 runs employing the low with dismount and/or pop-up tactic. (See Tables A147–A149.)

ANALYSIS OF FILM DATA

Introduction

Any field experiment that attempts to evaluate military tactics and doctrine can only hope at best to suggest what might occur in an actual conflict. The psychological factors having a marked influence on the outcome of a battle are obviously not present to a comparable degree in a field exercise. Although firm values cannot be given to such things as actual combat survivability and effectiveness, if the assumption can be made that these psychological factors act in a consistent manner it is possible to at least make comparisons of various tactics and doctrines.

Similarly, although film data can only begin to suggest live-fire effects, such data provide a means of making comparisons. It would be unrealistic to attempt a helicopter-vulnerability study based solely on gun-camera data, for such factors as visual means of adjusting fire and target reaction to fire are missing when employing gun cameras as a data-collection tool; but if these limitations are considered when analyzing and discussing the results of film-data collection, much useful information can be drawn from the data and comparisons can be made.

The film-data analysis was carried out in three steps: (a) film reading, (b) calculation of hit and survival probabilities, and (c) analysis of results.

Film Reading

Generally, the most tedious and time-consuming task associated with gun-camera film analysis is the actual extraction of pertinent information from the film. Since the angular field of view of the camera is a known constant, in this case, 62 mils, it is a simple matter to construct a rectangular grid system in 1-mil increments to serve as a measuring standard. Measurements are usually read to the nearest ½ mil. Greater accuracy cannot be expected when a large number of readings are required because of human fatigue inherent with prolonged periods in the film room or differences in human judgment if film readers are changed.

In this experiment camera data were recorded whenever the trigger of the gun was depressed, and the cameras continued to operate until the trigger was released making it possible to gather data on accuracy of the aiming point, duration of fire, and size of angular target directly from the film.

Miss Distance. Before a run each gun position fired at some fixed reference (e.g., the uppermost and center point on a telephone pole) to establish the aiming point of the weapon. The horizontal- and vertical-miss distances were

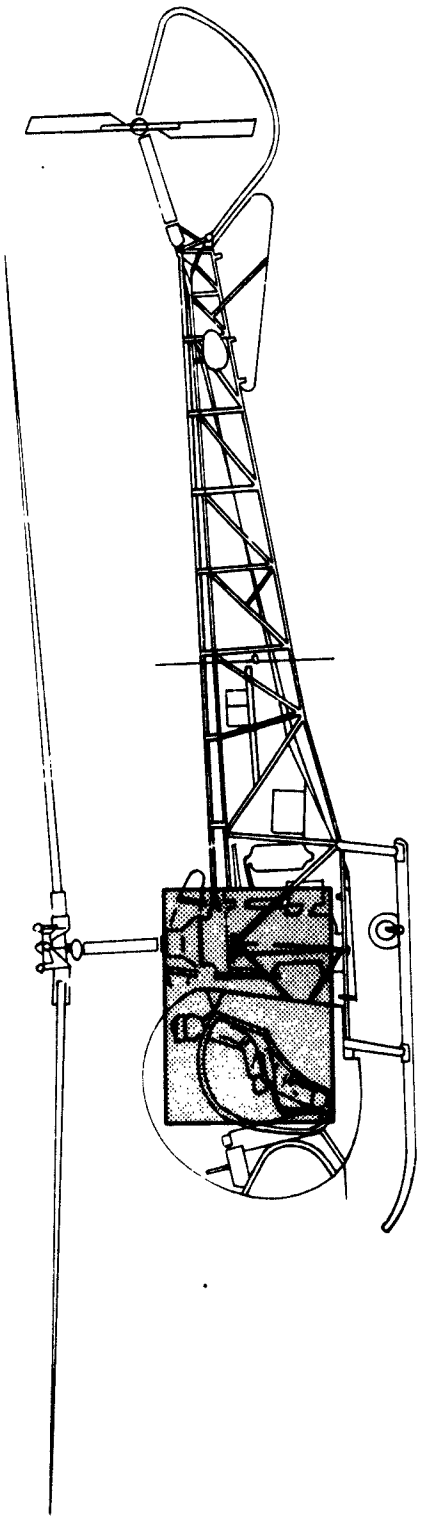


Fig. 13—Vulnerable Area of OH-13 Helicopter

defined as the horizontal and vertical deviations from the aiming point to the center of vulnerability of the helicopter target. A summary of miss distances by vehicle and range is presented in App D.

Target Size. The vulnerable area of the OH-13 helicopter was taken to be a rectangular area encompassing the pilot and engine (see Fig. 13). Because only small-arms fire was considered, hit and conditional kill probabilities on other parts of the aircraft were sufficiently small to be omitted when the objective was the uncovering of gross differences in tactics and employments rather than analysis of a sophisticated vulnerability or weapon-system performance.

Duration of Fire. The gun cameras operated at a speed of 16 frames/sec. The rate of fire of the machineguns used was 450 to 550 rounds/min (7.5 to 9.1 rounds/sec). Every second frame of film therefore corresponded approximately to the fire of one machinegun bullet. Although measurements were taken from each frame of film, only the values obtained from every second frame were used in the survival calculations made from the film data.

Calculation of Hit and Survival Probabilities

The probability of a target hit was calculated for each machinegun burst. Consequently the survival probability for each helicopter for every run was computed in the manner illustrated in Fig. 14.

Ballistic Characteristics. The assumption was made that the dispersion of a single round of machinegun fire was normally distributed about the mean center of impact in the horizontal and vertical dimensions. From information obtained at Development and Proof Services and Ballistic Research Laboratories a 2-mil dispersion was used for the .50-cal weapons on the tanks and APCs. A 4-mil dispersion was assumed for the .30-cal weapons on the jeeps and at the infantry positions. All fixed biases unaccountable in the accuracy of gun-camera lay were assumed to be zero.

Probability of a Hit. As can be seen from Fig. 14, the probability of a hit was taken to be the probability of the round impacting within the vulnerable area of the helicopter.

Conditional Kill Probabilities. This factor refers to the probability of obtaining a helicopter kill given a hit. Because of the difficulty in agreeing on realistic values for the conditional kill probabilities of the .30- and .50-cal weapon systems against the OH-13, calculations of survival probabilities were made at five levels of conditional kill probability: (a) 0.20, (b) 0.40, (c) 0.60, (d) 0.80, and (e) 1.00.

Probability of Survival. In all cases the probability of survival was calculated at all five conditional kill-probability levels for all firings at the particular helicopter during its mission. In runs using two helicopters the probability of survival was evaluated independently for each of the helicopters.

Weighted Number of Targets Acquired. Since some acquisitions were made by helicopters acquired and fired at by ground elements, a measure of acquisition capabilities that considers this effect is desirable. The weighted number of ground elements acquired WN was calculated to reflect this.

$$WN = \sum_{j=1}^{n} [PS(1:n)]_j$$

where: n is total number of ground elements acquired and i is total number of rounds fired at the helicopter at the same time of the jth acquisition.

For example, if the OH-13 locates a tank, is then fired at by the tank [with an associated $PK(i \leq r) = 0.3$], and then locates an APC, then $WN = 1.0 + 0.7 = 1.7$ since the helicopter had a 1.0 survival probability at the time of the first acquisition, but only a 0.7 probability of survival when the second acquisition was made.

In runs in which a pair of helicopters were used, the first helicopter to locate a ground element is given credit for acquisition. The weighted number

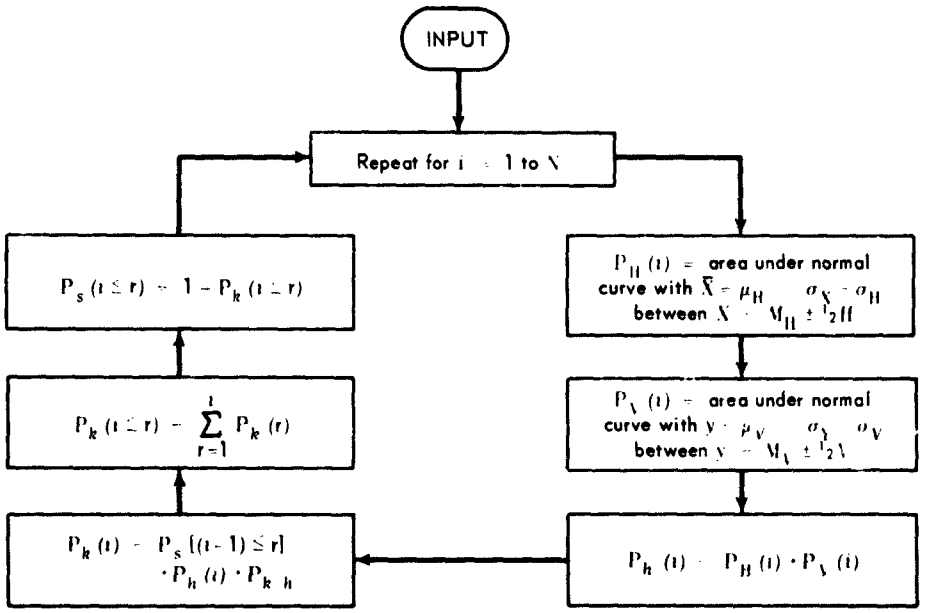


Fig. 14—Calculation of Hit and Survival Probabilities

INPUT

Film:

- H = target size, horizontal
- V = target size, vertical
- M_H = miss distance, horizontal
- M_V = miss distance, vertical
- N = number of rounds fired at helicopter during run

Weapon Characteristics:

- μ_H = fixed bias, horizontal
- μ_V = fixed bias, vertical
- σ_H = dispersion, horizontal
- σ_V = dispersion, vertical
- $P_{k|h}$ = conditional kill probability (constant value, independent of previous damage to aircraft)

OUTPUT

- $P_H(i)$ = probability of a horizontal hit for the ith round
- $P_V(i)$ = probability of a vertical hit for the ith round
- $P_h(i)$ = probability of a hit for the ith round
- $P_k(i)$ = probability of a kill for the ith round
- $P_k(i \leq r)$ = probability of a kill in i rounds
- $P_s(i \leq r)$ = probability of surviving i rounds

of ground elements acquired was then calculated on a "team basis," i.e., the aggregate weighted number of acquisitions for both helicopters was used.

Analysis of Results

Gun-camera data were used for (a) a survivability analysis, (b) a weighted acquisition analysis, and (c) a ratio of effectiveness analysis. The analyses are presented in the following three sections. Significance tests of the results appear in App B.

SURVIVABILITY ANALYSIS

A summary of the probability of survival by helicopter and run is presented in Table 10 for the five levels of conditional kill probabilities. These values have been grouped and compared to investigate the effects of (a) flying high, low, or low with dismount and/or pop-up; (b) reconnoitering against moving, dispersed, or concentrated units; and (c) employing helicopters singly and in pairs. The combined effects of a and c, i.e., flying high singly, high in pairs, low singly, etc., were also investigated.

Singles vs Pairs

The mean helicopter survivability for the 14 runs in which an OH-13 flew singly and the 13 runs in which pairs of helicopters were employed are grouped from Table 10 and presented in Table 11. The probability of survival in the cases where a pair reconnoitered was taken as the probability that both helicopters survived the mission, i.e., the product of their individual probabilities of survival.

Significance tests at the 5 percent level indicated that the differences noted in the table could have happened by chance (Tables B1 to B5). Under the conditions of this experiment flying helicopters in pairs seems to have no effect on survival probability until the 50 percent significance level is reached.

This result is not surprising considering the method in which the helicopter teams performed, i.e., in virtually all cases, to either fly together or divide the area of responsibility meeting at predetermined locations. In the former case ground elements were merely confronted with a multitarget or two targets spaced over a short interval. In the latter case the problem of a pair reconnoitering a 10-km^2 area was reduced to two problems of single helicopters reconnoitering a 5-km^2 area.

Variations in Tactics

If runs are grouped by tactics (Table 12), it becomes apparent that the probability of survival of helicopters employing the low with dismount and/or pop-up tactic was higher than the probabilities associated with the other two tactics. Statistical tests indicated that the observed differences could be expected to occur by chance less than 5 percent of the time (Tables B6 to B10).

No statistically significant difference was found between the survivability associated with the low and high tactics.

TABLE 10

Summary of Helicopter-Survival Probabilities

Run	Tactic	Helicopters used	Conditional kill-probability level									
			0.20		0.40		0.60		0.80		1.00	
			Helicopter									
			1	2	1	2	1	2	1	2	1	2
			Survival probability									
1-1	High	1	0.22	—	0 04	—	0 01	—	0.00	—	0.00	—
1-2	Low	2	0 83	0.68	0 69	0.43	0.57	0.26	0.47	0.14	0.38	0.06
1-3	High	2	0.48	0.93	0 23	0.86	0 11	0.80	0.05	0.74	0 02	0.68
1-4	Low	2	0 35	0 41	0 12	0.16	0.04	0 07	0.01	0.03	0.01	0.01
2-1	High	1	0.02	—	0 00	—	0.00	—	0 00	—	0.00	—
2-2	Low	2	0.75	0.02	0.56	0 00	0.42	0 00	0.31	0.00	0.23	0.00
2-3	Low	1	0 07	—	0.00	—	0.00	—	0.00	—	0.00	—
2-4	High	1	0.53	—	0 27	—	0 14	—	0.06	—	0.03	—
2-5	Low	1	0 01	—	0 00	—	0 00	—	0.00	—	0.00	—
2-6	High	2	0.57	0 30	0.32	0 09	0 18	0.03	0.10	0.01	0.06	0.00
3-1	Low	1	0.13	—	0 01	—	0.00	—	0.00	—	0.00	—
3-2	Low, dismount and/or pop-up	2	1.00	0.01	1.00	0 00	1.00	0.00	1 00	0.00	1.00	0.00
3-3	Low	1	0.43	—	0.18	—	0.08	—	0.03	—	0.01	—
3-4	Low, dismount and/or pop-up	2	0.01	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-5	High	1	0 78	—	0 60	—	0.47	—	0 36	—	0.28	—
3-6	Low, dismount and/or pop-up	2	0 78	0.74	0.60	0.55	0.47	0.41	0.36	0.30	0.28	0.22
4-1	High	1	0.48	—	0 23	—	0.11	—	0.05	—	0.02	—
4-2	Low, dismount and/or pop-up	2	1.00	1 00	1 00	1.00	1.00	1.00	1.00	1.00	1.00	1 00
4-3	Low, dismount and/or pop-up	1	0.80	—	0.64	—	0.50	—	0.39	—	0.30	—
4-4	Low, dismount and/or pop-up	2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1 00	1.00	1.00
4-5	High	2	0.74	0.47	0.55	0.22	0.39	0.10	0.28	0.04	0.19	0.02
4-6	High	1	0.14	—	0.02	—	0.00	—	0.00	—	0.00	—
5-1	Low, dismount and/or pop-up	1	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—
5-2	Low	2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5-3	Low, dismount and/or pop-up	1	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—
5-4	Low, dismount and/or pop-up	1	0 02	—	0.00	—	0.00	—	0.00	—	0.00	—
5-5	Low, dismount and/or pop-up	2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

TABLE 11

Comparison of Mean Survival Probabilities for Helicopters Used Singly and in Pairs

Helicopters used	Runs	Conditional kill-probability level				
		0.20	0.40	0.60	0.80	1.00
		Mean helicopter-survival probability				
1	14	0.40	0.29	0.24	0.21	0.19
2	13	0.48	0.38	0.34	0.33	0.32

TABLE 12

Comparison of Mean Helicopter-Survival Probabilities by Reconnaissance Tactic

Tactic	Helicopters used	Conditional kill-probability level				
		0.20	0.40	0.60	0.80	1.00
		Mean helicopter-survival probability				
High	12	0.47	0.29	0.19	0.14	0.11
Low	12	0.47	0.35	0.29	0.25	0.23
Low, dismount and or pop-up	16	0.71	0.68	0.65	0.63	0.61

TABLE 13

Comparison of Mean Helicopter-Survival Probabilities by Tactic for Helicopters Used Singly and in Pairs

Tactic	Helicopters	Runs	Conditional kill-probability level				
			0.20	0.40	0.60	0.80	1.00
			Mean helicopter-survival probabilities				
High	1	6	0.36	0.19	0.12	0.08	0.06
	2	3	0.32	0.12	0.04	0.01	0.01
Low	1	4	0.16	0.04	0.02	0.01	0.00
	2	4	0.43	0.33	0.29	0.27	0.26
Low, dismount and or pop-up	1	4	0.71	0.66	0.63	0.60	0.58
	2	6	0.60	0.56	0.53	0.52	0.51

These results, although not necessarily predictable in advance, are not surprising. The low with dismount and/or pop-up tactic necessarily requires a more cautious manner of reconnoitering and hence offers a greater chance of avoiding enemy fire. The tactic of flying low without pop-up or dismounting an observer increases the possibility of flying within range of enemy fire. Similarly, the high tactic would entail greater chance of flying over hostile area.

Variations in Tactics and Number of Helicopters

The survivability data were grouped by tactic and number of helicopters, and the means of the six possible conditions were calculated. These results appear in Table 13. The probability of survival when a pair reconnoitered was taken as the probability that both helicopters survived the mission. The differences in these means were not found to be significant until the 10 percent level (Tables B11 and B12).

Variations in Complexes

Mean helicopter-survival probabilities by ground complex, i.e., dispersed, concentrated, and moving, were calculated from Tables 2 and 10 and are presented in Table 14. It can be shown that the increased survivability against the moving complex was not simply due to chance.

TABLE 14

Comparison of Mean Helicopter-Survival Probabilities by Ground Complex

Complex	Runs	Helicopters used	Conditional kill-probability level				
			0.20	0.40	0.60	0.80	1.00
			Mean helicopter-survival probability				
Dispersed	10	15	0.11	0.25	0.17	0.13	0.10
Concentrated	13	19	0.56	0.45	0.40	0.36	0.33
Moving	4	6	1.00	1.00	1.00	1.00	1.00

The concept of a more mobile and fluid enemy is being given greater consideration than ever before in military thinking. The fact that the helicopter has an increased probability of survival against a moving complex suggests that emphasis on the employment of the aircraft in such a role would be advantageous.

Survivability Analysis Findings

(a) The technique of flying low and employing pop-ups and/or dismounts was superior to the other two techniques examined.

(b) No significant difference was observed between flying high or low.

(c) Helicopters were more effective when reconnoitering against a moving complex than against concentrated or dispersed ones.

(d) When helicopters were employed in pairs rather than singly, results were not significantly different.

WEIGHTED ACQUISITION ANALYSIS

The number of ground elements available and actual and weighted number of acquisitions for each of the 27 runs are presented in Table 15. The weighted number differs from the actual number in that it considers the probability of survival of the helicopter at the time of acquisition. When a pair of helicopters performed the reconnaissance mission, the team was given credit for an acquisition by either of the helicopters, and all comparisons were made considering team rather than individual performance.

For each run the weighted fraction acquired was computed as follows:

$$\text{Weighted fraction acquired} = \frac{\text{weighted number acquired}}{\text{actual number available}}$$

These values were grouped and compared to investigate the effects of (a) variations in tactics, (b) variations in tactics and number of helicopters, (c) variations in complexes, and (d) singles vs pairs. The mean weighted fraction acquired was calculated by each of these groups, and the results are presented in Tables 16 to 19.

As will be seen in Tables B18 to B21 in App B no significant differences were found for any of these comparisons.

RATIO OF EFFECTIVENESS ANALYSIS

To estimate the effectiveness of each of the helicopter runs a ratio of effectiveness (r) was calculated as follows:

$$r = \frac{\text{weighted number of ground targets acquired}}{\text{number of downed helicopters}}$$

where
- $P_s(1)$ = survival probability for helicopter 1
- $P_s(2)$ = survival probability for helicopter 2
- $1 - P_s(1)$ = number of downed helicopters (for runs with one helicopter)
- $2 - P_s(1) - P_s(2)$ = number of downed helicopters (for runs with two helicopters)

A summary of these calculations appears in Tables 20 to 23.

The ratios of effectiveness for the entire summer phase are presented in Table 24.

UNANALYZABLE FILM

Twenty-one percent of the film data (20 out of 97 firings) were unanalyzable because of technical difficulties. Table 25 indicates the amount of unanalyzable film by run.

TABLE 15

Summary of Weighted Number of Targets Acquired WN

Run	Flight tactic	Helicopters used	Ground elements: Available	Ground elements: Acquired by helicopter: 1	2	1 or both	Conditional kill-probability level: 0.20 Helicopter: 1	2	1 or both	0.40: 1	2	1 or both	0.60: 1	2	1 or both	0.80: 1	2	1 or both	1.00: 1	2	1 or both
							WN														
1-1	High	1	4	2	—	2	0.47	—	0.47	0.09	—	0.09	0.01	—	0.01	0.00	—	0.00	0.00	--	0.00
1-2	Low	2	4	1	2	3	1.00	1.36	2.36	1.00	0.88	1.88	1.00	0.26	1.26	1.00	0.14	1.14	1.00	0.06	1.06
1-3	High	2	5	2	1	3	2.00	1.00	3.00	2.00	1.00	3.00	2.00	1.00	3.00	2.00	1.00	3.00	2.00	1.00	3.00
1-4	Low	2	5	0	1	1	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00
2-1	High	1	5	3	—	3	1.07	—	1.07	0.72	—	0.72	0.56	—	0.56	0.45	—	0.45	0.37	—	0.37
2-2	Low	2	5	2	1	3	2.00	0.04	2.04	2.00	0.00	2.00	2.00	0.00	2.00	2.00	0.00	2.00	2.00	0.00	2.00
2-3	Low	1	5	2	—	2	0.72	—	0.72	0.38	—	0.38	0.23	—	0.23	0.14	—	0.14	0.08	—	0.08
2-4	High	1	5	2	—	2	2.00	—	2.00	2.00	—	2.00	2.00	—	2.00	2.00	—	2.00	2.00	—	2.00
2-5	Low	1	5	4	—	4	3.07	—	3.07	3.00	—	3.00	3.00	—	3.00	3.00	—	3.00	3.00	—	3.00
2-6	High	2	5	2	1	3	1.82	0.30	2.12	1.67	0.09	1.76	1.55	0.03	1.58	1.45	0.01	1.46	1.37	0.00	1.37
3-1	Low	1	5	2	—	2	0.27	—	0.27	0.03	—	0.03	0.00	—	0.00	0.00	—	0.00	0.00	—	0.00
3-2	Low, dismount and/or pop-up	2	5	1	1	2	1.00	0.01	1.01	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
3-3	Low	1	5	2	—	2	1.43	—	1.43	1.18	—	1.18	1.08	—	1.08	1.03	—	1.03	1.01	—	1.01
3-4	Low, dismount and/or pop-up	2	5	0	2	2	0.00	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-5	High	1	5	1	—	1	0.90	—	0.90	0.81	—	0.81	0.73	—	0.73	0.66	—	0.66	0.59	—	0.59
3-6	Low, dismount and/or pop-up	2	5	3	1	4	2.64	1.00	3.64	2.35	1.00	3.35	2.10	1.00	3.10	1.90	1.00	2.90	1.73	1.00	2.73
4-1	High	1	5	2	—	2	2.00	—	2.00	2.00	—	2.00	2.00	—	2.00	2.00	—	2.00	2.00	—	2.00
4-2	Low, dismount and/or pop-up	2	5	3	0	3	3.00	0.00	3.00	3.00	0.00	3.00	3.00	0.00	3.00	3.00	0.00	3.00	3.00	0.00	3.00
4-3	Low, dismount and/or pop-up	1	5	1	—	1	0.80	—	0.80	0.64	—	0.64	0.50	—	0.50	0.39	—	0.39	0.30	—	0.30
4-4	Low, dismount and/or pop-up	2	5	1	2	3	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00
4-5	High	2	5	0	2	2	0.00	0.94	0.94	0.00	0.43	0.43	0.00	0.19	0.19	0.00	0.08	0.08	0.06	0.03	0.03
4-6	High	1	5	3	—	3	3.00	—	3.00	3.00	—	3.00	3.00	—	3.00	3.00	—	3.00	3.00	—	3.00
5-1	Low, dismount and/or pop-up	1	4	3	—	3	3.00	—	3.00	3.00	—	3.00	3.00	—	3.00	3.00	—	3.00	3.00	—	3.00
5-2	Low	2	5	2	0	2	2.00	0.00	2.00	2.00	0.00	2.00	2.00	0.00	2.00	2.00	0.00	2.00	2.00	0.00	2.00
5-3	Low, dismount and/or pop-up	1	4	1	0	1	1.00	—	1.00	1.00	—	1.00	1.00	—	1.00	1.00	—	1.00	1.00	—	1.00
5-4	Low, dismount and/or pop-up	1	4	2	—	2	0.04	—	0.04	0.00	—	0.00	0.00	—	0.00	0.00	—	0.00	0.00	—	0.00
5-5	Low, dismount and/or pop-up	2	4	2	0	2	2.00	0.00	2.00	2.00	0.00	2.00	2.00	0.00	2.00	2.00	0.00	2.00	2.00	0.00	2.00

TABLE 16

Comparison of Mean Weighted Fraction Acquired, by Helicopters Used

Helicopters used	Runs	Conditional kill-probability level				
		0.20	0.40	0.60	0.80	1.00
		Mean weighted fraction acquired				
1	14	0.30	0.27	0.26	0.25	0.25
2	13	0.42	0.39	0.37	0.36	0.35

TABLE 17

Comparison of Mean Weighted Fraction Acquired, by Reconnaissance Tactic

Tactic	Runs	Conditional kill-probability level				
		0.20	0.40	0.60	0.80	1.00
		Mean weighted fraction acquired				
High	9	0.35	0.31	0.29	0.28	0.28
Low	8	0.34	0.30	0.27	0.27	0.26
Low, dismount and/or pop-up	10	0.38	0.37	0.36	0.36	0.35

TABLE 18

Comparison of Mean Weighted Fraction Acquired, by Reconnaissance Tactic and Helicopters Used

Tactic	Helicopters used	Runs	Conditional kill-probability level				
			0.20	0.40	0.60	0.80	1.00
			Mean weighted fraction acquired				
High	1	6	0.32	0.29	0.28	0.27	0.27
	2	3	0.40	0.35	0.32	0.30	0.29
Low	1	4	0.28	0.23	0.22	0.21	0.21
	2	1	0.40	0.37	0.33	0.32	0.32
Low, dismount and/or pop-up	1	1	0.29	0.28	0.28	0.27	0.27
	2	6	0.44	0.43	0.42	0.41	0.41

TABLE 19

Comparison of Mean Weighted Fraction Acquired, by Ground Complex

Complex	Runs	Conditional kill-probability level				
		0.20	0.40	0.60	0.80	1.00
		Mean weighted fraction acquired				
Dispersed	10	0.37	0.33	0.30	0.29	0.28
Concentrated	13	0.31	0.28	0.27	0.26	0.26
Moving	4	0.48	0.48	0.48	0.48	0.48

TABLE 20

Comparison of Ratios of Effectiveness by Helicopters Used

Helicopters used	Runs	Conditional kill-probability level				
		0.20	0.40	0.60	0.80	1.00
		Ratio of effectiveness				
1	14	2.41	1.78	1.60	1.50	1.44
2	13	3.33	2.10	1.76	1.59	1.50

TABLE 21

Comparison of Ratios of Effectiveness by Reconnaissance Tactic

Tactic	Runs	Conditional kill-probability level				
		0.20	0.40	0.60	0.80	1.00
		Ratio of effectiveness				
High	9	2.44	1.61	1.35	1.23	1.16
Low	8	2.04	1.46	1.23	1.14	1.09
Low, dismount and or pop-up	10	5.00	3.26	2.95	2.74	2.59

TABLE 22

Comparison of Ratios of Effectiveness by Reconnaissance Tactic and Helicopters Used

Tactic	Helicopters used	Runs	Conditional kill-probability level				
			0.20	0.40	0.60	0.80	1.00
			Ratio of effectiveness				
High	1	6	2.46	1.78	1.57	1.47	1.40
	2	3	2.41	1.39	1.09	0.95	0.87
Low	1	4	1.63	1.20	1.10	1.05	1.03
	2	4	2.50	1.70	1.35	1.22	1.14
Low, dismount and/or pop-up	1	4	4.41	3.41	3.00	2.73	2.53
	2	6	5.29	3.21	2.94	2.74	2.61

TABLE 23

Comparison of Ratios of Effectiveness by Ground Complex

Complex	Runs	Conditional kill-probability level				
		0.20	0.40	0.60	0.80	1.00
		Ratios of effectiveness				
Dispersed	10	2.02	1.41	1.18	1.08	1.03
Concentrated	13	2.78	1.77	1.53	1.40	1.31
Moving	4	∞	∞	∞	∞	∞

TABLE 24

Summary of Film Data Analysis for 27 Runs

Conditional kill-probability level	Weighted number of ground targets acquired	Helicopters downed	Ratio of effectiveness
0.20	46.35	16.25	2.85
0.40	42.27	21.63	1.95
0.60	40.24	23.84	1.69
0.80	39.25	25.27	1.55
1.00	38.54	26.20	1.47

TABLE 25

Summary of Unanalyzable Film Data

Run	Tactic	Helicopters used	Firings			
			Analyzable	Unanalyzable	Total	Percent unanalyzable
1-1	High	1	3	1	4	25
1-2	Low	2	3	1	4	25
1-3	High	2	2	1	3	33
1-4	Low	2	4	0	4	0
2-1	High	1	6	1	7	14
2-2	Low	2	8	0	8	0
2-3	Low	1	3	1	4	25
2-4	High	1	4	0	4	0
2-5	Low	1	5	0	5	0
2-6	High	2	8	2	10	20
3-1	Low	1	3	0	3	0
3-2	Low, dismount and/or pop-up	2	1	0	1	0
3-3	Low	1	4	0	4	0
3-4	Low, dismount and/or pop-up	2	2	0	2	0
3-5	High	1	3	1	4	25
3-6	Low, dismount and/or pop-up	2	4	1	5	20
4-1	High	1	1	1	2	50
4-2	Low, dismount and/or pop-up	2	0	0	0	0
4-3	Low, dismount and/or pop-up	1	2	0	2	0
4-4	Low, dismount and/or pop-up	2	0	0	0	0
4-5	High	2	4	5	9	55
4-6	High	1	3	4	7	57
5-1	Low, dismount and/or pop-up	1	0	1	1	100
5-2	Low	2	0	0	0	0
5-3	Low, dismount and/or pop-up	1	0	0	0	0
5-4	Low, dismount and/or pop-up	1	4	0	4	0
5-5	Low, dismount and/or pop-up	2	0	0	0	0
	Total		77	20	97	21

CONCLUSIONS

Based on the preceding analyses of the time and film data and comments by military personnel at various levels of command it is concluded that:

1. Area reconnaissance in the forward areas is indeed risky, and helicopters should be used with due caution.

2. The tactic of flying nap of the earth and employing pop-ups and dismounts as the terrain and situation warrant is superior to flying at treetop level or straight nap of the earth.

3. Generally speaking, a 1:2:3 ratio exists in time required to complete a reconnaissance mission when using the techniques of flying high, low, and low with pop-ups and/or dismounts respectively.

4. Under the conditions of the experiment flying in pairs did not markedly influence mission effectiveness. However, other considerations should be weighed. The assignment of two helicopters to a reconnaissance mission increases the probability that one will return with the needed information. In addition, definite psychological advantages accrue to pilots working in pairs. Specifically, pilots and crew chiefs will be less apprehensive about ambush, personal safety, and possible rescue. Also, pilots state that search techniques can be better implemented when working in pairs.

5. In the limited cases where moving complexes were examined, the helicopter was found to be most effective.

Appendix A

STATISTICAL ANALYSIS OF ACQUISITION DATA

Tables

INTRODUCTION

The detailed analysis of the two-sided acquisition data contained in Tables 1 to 3 and supplementary analyses of helicopter-mission times and acquisition-time advantages are presented in this appendix in Tables A1 to A149.

In the 27 helicopter-reconnaissance runs a number of experimental variables were not controlled as closely as is statistically desirable. To a large extent this was unavoidable because statistical control must frequently be sacrificed to achieve desired levels of tactical realism or to utilize troops and equipment when they are available. Among the factors that could have influenced the experimental results but were not rigorously taken into account in the design of the experiment were (a) time of day when the flights were made, (b) such differences in scenario variations as the amount of battlefield noise reaching observers from run to run, and (c) pilot learning during the experiment.

The small number of runs obtained also presented statistical difficulties. Although it was planned to investigate each combination of ground employment, helicopter tactics, and number of helicopters per run, there was time during the period that troops were available to examine only 12 of the 18 possible combinations.

As a result of considerations such as these, statistical analysis was directed toward making gross comparisons between the main factors varied. The aerial factors were number of helicopters used per run (one or two) and reconnaissance technique employed (flying high, low, or low with dismount and/or pop-up). Differences in ground scenarios were attributed to mode of employment (moving, dispersed, or concentrated) and mix of ground elements (tanks, jeeps, APCs, infantry). Where it was realized that interactions between main factors existed, special breakdowns of the data were made.

MEASURE OF EFFECTIVENESS

In analyzing the data the following measures of acquisition effectiveness were used: (a) number of one-sided acquisitions recorded by air and ground elements, (b) number of times one side enjoyed an interacquisition advantage

over the other, (c) total number of times one side reported an acquisition advantage over the other, and (d) number of targets acquired by each side compared with the number available. The acquisition data pertaining to each of these effectiveness measures is presented in Tables 1 to 3. One-sided acquisitions refer to those sightings in which one side saw the other but was not seen in return; hence for sightings of this type one side enjoyed a finite but unmeasurable acquisition-time advantage over the other. This acquisition measure also includes those cases in which a ground element reacquired a helicopter on a subsequent pass after the helicopter had disappeared from view on an earlier pass. Interacquisitions refer to those instances in which one side saw the other but was acquired in return. This type of sighting resulted in measurable acquisition-time advantages. Total acquisition refers to the total number of times one side possessed a time advantage over the other; total acquisition data were obtained by summing the data presented in Tables 1 and 2. Item d measures targets acquired compared with available targets. The potential number of helicopter sightings for the ground force on a particular run is defined as the number of ground elements present times the number of helicopters dispatched. On the other hand the number of ground targets available for air-to-ground acquisition was not considered a function of the number of helicopters employed. As soon as one member of a helicopter team saw a ground element the pair was given credit for the acquisition.

RESULTS OF STATISTICAL TESTS

Chi-square tests were used in comparing (a) the number of targets seen compared with those available, (b) the ability of the different types of ground elements to acquire helicopters, and (c) the ability of helicopters to acquire different ground elements. The following tables in this appendix contain Chi-square analyses: A11–A13, A23–A26, A37–A39, A49–A52, A63–A67, and A77–A105. Major findings are summarized below:

(a) The types of ground elements studied differ in their ability to obtain acquisition advantages against the helicopter. The smaller elements (jeeps, infantry) acquired aerial targets without being seen in return significantly more often than the larger-sized vehicles (tanks, APCs). Stationary ground elements recorded significantly more acquisition advantages than moving ground elements. And finally, in terms of overall acquisition advantages, the smaller elements were more effective than the larger; the stationary, than the moving. Infantry scored significantly more acquisition advantages than expected from the number present; APCs, significantly less.

(b) Based on the number of helicopters acquired compared with the number available one type of ground element was about as effective as another. The fact that no significant differences in helicopter-sighting frequency were detected can be partly attributed to the relatively large number of helicopters acquired. Of 192 possible helicopter sightings 134 actual sightings were reported.

(c) On the other hand helicopters acquired some types of ground elements more easily than other kinds. Small elements such as jeeps and infantry appeared more

difficult to detect than the larger elements, e.g., tanks appeared to be more easily observed.

(d) Fewer available helicopters were seen when pilots used the low with dismount and/or pop-up technique than with other techniques. Moving ground employments saw helicopters less frequently than stationary dispersed or stationary concentrated complexes saw them.

(e) Type of helicopter-reconnaissance technique had little effect on helicopters' ability to acquire available ground elements. Approximately 50 percent of the ground targets available were acquired for each of the three tactics flown.

The remaining acquisition-advantage data were analyzed using t tests. Since much of the data included reacquisitions, Chi-square tests based on the number of acquisition advantages available were not applicable. Tables A1, A27, and A53 contain comparisons of the acquisition effectiveness of helicopters and ground elements. These analyses indicate that the ground elements scored significantly more acquisition advantages than the helicopters; ground elements repeatedly saw helicopters before the helicopters acquired ground elements in return.

Tables A2–A10, A14–A22, A28–A36, A40–A48, A54–A62, and A68–A76 present t tests based on small-sample statistics. The prerequisite F tests to determine whether the sample variances may be pooled indicate that the method used was applicable. The more important findings are summarized below:

(a) Flying in pairs did not increase the acquisition effectiveness of the helicopter. On the other hand ground elements scored about as many acquisition advantages against single helicopters as against pairs.

(b) Ground elements had significantly fewer advantages against helicopters employing the low with dismount and/or pop-up tactic than against other tactics. Equally important is the fact that helicopters flying low with dismount and/or pop-up acquired more ground elements without being seen in return than helicopters using the other reconnaissance techniques.

(c) Moving ground employments registered significantly fewer acquisition advantages than concentrated or dispersed elements.

A summary of the 105 analyses just discussed is presented in Tables 8 and 9.

INTERACTION ANALYSIS

At best these statistical analyses represent gross comparisons. Interactions between the major factors varied tend to obscure the conclusions drawn. The most serious interaction observed occurred when the best helicopter-reconnaissance tactic (flying low with dismount and/or pop-up) was played against the least effective ground employment (moving), and only one observation of another reconnaissance tactic against moving ground forces was made. Hence it is difficult to determine how much of the helicopter's success on the fifth day was attributable to the dismount and/or pop-up tactic and how much was attributable to flying against a moving armor column.

Additional statistical analyses were carried out to learn whether this interaction seriously affected the findings listed above. In these analyses comparisons were made to determine whether the low with dismount and/or pop-up tactic was superior to other reconnaissance techniques against dispersed and

concentrated ground elements and to determine whether pilots employing the low with dismount and/or pop-up tactic were more effective against the moving armor column than against the other types of ground employment studied. The analyses presented in Tables A106–A138 investigate helicopter performance against ground elements other than moving. The analyses produced the following findings.

(a) Ground elements obtained significantly more acquisition advantages than the helicopters did.

(b) Flying individually or in pairs did not appear to affect the number of acquisition advantages scored by the ground or aerial elements.

(c) Most importantly, flying with the low with dismount and/or pop-up tactic still appears more effective than flying with the high or low tactics, although the margin of difference is noticeably smaller than when the moving armor-column data were included in the analysis. One can still be over 95 percent confident, however, that ground elements score significantly more overall-acquisition advantages against helicopters flying high or low than against helicopters employing the low with dism unt and/or pop-up tactic.

Analyses presented in Tables A139–A144 compare the effectiveness of the low with dismount and/or pop-up tactic against moving vs concentrated ground employments.

SUPPLEMENTARY ANALYSES

Supplementary analyses concerning the duration of interacquisition advantages and helicopter missions have also been included in App A. Tables A145 and A146 summarize the duration of the interacquisition advantages observed in the experiment. The mean time advantage for ground units was 12 sec and the median advantage 10 sec. On the other hand the mean interacquisition time advantage for helicopters was only 6 sec and the median advantage 4 sec.

Analyses of the length of time required for helicopters to complete their missions with each of the three reconnaissance techniques were also made. It was found that an average of 10.5 min was required to complete the 9 runs flying high; an average of 21.5 min, the 8 runs flying low; and an average of 35.5 min, the 10 runs employing the low with dismount and/or pop-up tactic. The statistical tests presented in Tables A147–A149 indicate that the differences in time required to complete high missions compared with low, and high missions compared with low with dismount and/or pop-up missions are highly significant.

TABLE A1

One-Sided Acquisition Advantages

(Ground compared with air)

Side	Run																										
	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	4-1	4-2	4-3	4-4	4-5	4-6	5-1	5-2	5-3	5-4	5-5	Total
	Advantages																											
Ground	4	3	11	8	7	11	4	3	3	9	3	3	7	8	11	5	2	0	3	2	8	5	0	2	2	4	0	128
Air	0	0	1	1	1	0	0	1	2	0	0	2	0	1	0	1	0	3	1	3	1	0	2	0	1	2	2	25
Difference x	4	3	10	7	6	11	4	2	1	9	3	1	7	7	11	4	2	-3	2	-1	7	5	-2	2	1	2	-2	103

Average difference $\bar{x} = \frac{\Sigma x}{n} = \frac{103}{27} = 3.815$

Sample variance $s^2 \quad \frac{\Sigma x^2}{n} - \bar{x}^2 \quad 11.594$

Student's $t \quad \frac{\bar{x}\sqrt{n-1}}{s} = 5.092$

Tabular $t_{(m = 26,\ \epsilon = 0.001)} = 3.707$

TABLE A2

One-Sided Ground-to-Air Acquisition Advantages

(One compared with two helicopters)

Helicopters used	Observation														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
	Advantages														
1	4	7	4	3	3	3	7	11	2	3	5	0	2	4	58
2	3	11	8	11	9	3	8	5	0	2	8	2	0	—	70

Observations – one helicopter n_1	= 14
Observations – two helicopters n_2	= 13
Sample variance – one helicopter s_1^2	= 6.837
Sample variance – two helicopters s_2^2	= 14.544
Pooled estimate of variance $\hat{\sigma}^2 = \frac{n_1 s_1^2 + n_2 s_2^2}{n_1 + n_2 - 2}$	= 11.392
Best estimate of standard error of difference $\hat{\sigma}_w = \hat{\sigma}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$	= 1.300
Student's t	= 0.955
Tabular $t_{(m = 25,\ \epsilon = 0.30)}$	1.058
Tabular $t_{(m = 25,\ \epsilon = 0.40}$	0.856

TABLE A3

One-Sided Ground-to-Air Acquisition Advantages

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	4	11	7	3	9	11	2	8	5	60
Low	3	8	11	4	3	3	7	2	—	41

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 8
Sample variance – high tactic s_1^2	= 9.995
Sample variance – low tactic s_2^2	= 8.859
Pooled estimate of variance $\hat{\sigma}^2$	= 10.722
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.592
Student's t	= 0.968
Tabular $t_{(m = 15,\ \epsilon = 0.40)}$	= 0.866
Tabular $t_{(m = 15,\ \epsilon = 0.30)}$	= 1.074

TABLE A4

One-Sided Ground-to-Air Acquisition Advantages

(High compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
High	4	11	7	3	9	11	2	8	5	—	60
Low, dismount and/or pop-up	3	8	5	0	3	2	0	2	4	0	27

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high tactic s_1^2	= 9.995
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 5.810
Pooled estimate of variance $\hat{\sigma}^2$	= 8.709
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.355
Student's t	= 2.928
Tabular $t_{(m = 17,\ \epsilon = 0.01)}$	= 2.898
Tabular $t_{(m = 17,\ \epsilon = 0.001)}$	= 3.965

TABLE A5

One-Sided Ground-to-Air Acquisition Advantages

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Low	3	8	11	4	3	3	7	2	—	—	41
Low, dismount and/or pop-up	3	8	5	0	3	2	0	2	4	0	27

Observations – low tactic n_1	= 8
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – low tactic s_1^2	= 8.859
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 5.810
Pooled estimate of variance $\hat{\sigma}^2$	= 8.061
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.346
Student's t	= 1.802
Tabular $t_{(m = 16,\ \epsilon = 0.10)}$	= 1.746
Tabular $t_{(m = 16,\ \epsilon = 0.05)}$	= 2.120

TABLE A6

One-Sided Ground-to-Air Acquisition Advantages

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
	Advantages																	
High, low	4	3	11	8	7	11	4	3	3	9	3	7	11	2	8	5	2	101
Low, dismount and/or pop-up	3	8	5	0	3	2	0	2	1	0	—	—	—	—	—	—	—	27

Observations – high, low tactics n_1	= 17
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high, low tactics s_1^2	= 10.055
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 5.810
Pooled estimate of variance $\hat{\sigma}^2$	= 9.162
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.320
Student's t	= 2.456
Tabular $t_{(m = 25,\ \epsilon = 0.05)}$	= 2.060
Tabular $t_{(m = 25,\ \epsilon = 0.02)}$	= 2.485

TABLE A7

One-Sided Ground-to-Air Acquisition Advantages

(Moving compared with dispersed ground employment)

Employment	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Moving	0	2	2	0	—	—	—	—	—	—	4
Dispersed	4	3	11	8	7	11	4	3	3	9	63

Observations – moving elements n_1	= 4
Observations – dispersed elements n_2	= 10
Sample variance – moving elements s_1^2	= 1.000
Sample variance – dispersed elements s_2^2	= 9.810
Pooled estimate of variance $\hat{\sigma}^2$	= 8.503
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.726
Student's t	= 3.071
Tabular $t_{(m = 12,\ \epsilon = 0.01)}$	= 3.055
Tabular $t_{(m = 12,\ \epsilon = 0.001)}$	= 4.318

TABLE A8

One-Sided Ground-to-Air Acquisition Advantages

(Moving compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Moving	0	2	2	0	—	—	—	—	—	—	—	—	—	4
Concentrated	3	3	7	8	11	5	2	0	3	2	8	5	4	61

Observations – moving elements n_1	= 4
Observations – concentrated elements n_2	= 13
Sample variance – moving elements s_1^2	= 1.000
Sample variance – concentrated elements s_2^2	= 8.677
Pooled estimate of variance $\hat{\sigma}^2$	= 7.787
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.596
Student's t	= 2.313
Tabular $t_{(m = 15,\ \epsilon = 0.05)}$	= 2.131
Tabular $t_{(m = 15,\ \epsilon = 0.02)}$	= 2.602

TABLE A9

One-Sided Ground-to-Air Acquisition Advantages

(Dispersed compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Dispersed	4	3	11	8	7	11	4	3	3	9	—	—	—	63
Concentrated	3	3	7	8	11	5	2	0	3	2	8	5	4	61

Observations – dispersed elements n_1	= 10
Observations – concentrated elements n_2	= 13
Sample variance – dispersed elements s_1^2	= 9.810
Sample variance – concentrated elements s_2^2	= 8.677
Pooled estimate of variance $\hat{\sigma}^2$	= 10.043
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.333
Student's t	= 1.206
Tabular $t_{(m = 21,\ \epsilon = 0.30)}$	= 1.063
Tabular $t_{(m = 21,\ \epsilon = 0.20)}$	= 1.323

TABLE A10

One-Sided Ground-to-Air Acquisition Advantages

(Moving, compared with dispersed, concentrated ground employment)

Employment	Observation																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	Advantages																							
Moving	0	2	2	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
Dispersed, concentrated	4	3	11	8	7	11	4	3	3	9	3	3	7	8	11	5	2	0	3	2	6	5	4	124

Observations – moving elements n_1	= 4
Observations – dispersed, concentrated elements n_2	= 23
Sample variance – moving elements s_1^2	= 1.000
Sample variance – dispersed, concentrated elements s_2^2	= 9.807
Pooled estimate of variance $\hat{\sigma}^2$	= 9.182
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.639
Student's t	= 2.679
Tabular $t_{(m = 25,\ \epsilon = 0.02)}$	= 2.485
Tabular $t_{(m = 25,\ \epsilon = 0.01)}$	= 2.787

TABLE A11

One-Sided Ground-to-Air Acquisition Advantages

(Comparison of ground elements)

Ground element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Tank	22	19	21.760	0.350
Jeep	34	42	33.792	1.994
Moving jeep	18	19	17.920	0.065
APC	20	17	19.840	0.406
Moving APC	19	4	18.816	11.668
Infantry	16	27	15.872	0.701
Total	129	128	128.000	15.184

$$\chi^2_{(m=5,\ \epsilon=0.01)} = 15.086$$

$$\chi^2_{(m=5,\ \epsilon=0.001)} = 20.517$$

TABLE A12

One-Sided Ground-to-Air Acquisition Advantages

(Moving compared with stationary employment)

Employment	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Moving	37	23	36.736	5.136
Stationary	92	105	91.264	0.150
Total	129	128	128.000	5.286

$$\chi^2_{(m=1,\ \epsilon=0.05)} = 3.841$$

$$\chi^2_{(m=1,\ \epsilon=0.02)} = 5.412$$

TABLE A13

One-Sided Ground-to-Air Acquisition Advantages

(Large compared with small ground elements)

Size	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Large	61	40	60.544	6.971
Small	68	88	67.456	6.257
Total	129	128	128.000	13.228

$$\chi^2_{(m=1,\ \epsilon=0.001)} = 10.827$$

TABLE A14

One-Sided Air-to-Ground Acquisition Advantages

(One compared with two helicopters)

Helicopters used	Observation														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
	Advantages														
1	0	1	0	1	2	0	0	0	0	1	0	2	1	2	10
2	0	1	1	0	0	2	1	1	3	3	1	0	2	—	15

Observations – one helicopter n_1	= 14
Observations – two helicopters n_2	= 13
Sample variance – one helicopter s_1^2	= 0.721
Sample variance – two helicopters s_2^2	= 0.882
Pooled estimate of variance $\hat{\sigma}^2$	= 0.869
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.932
Student's t	= 1.229
Tabular $t_{(m = 25,\ \epsilon = 0.30)}$	= 1.058
Tabular $t_{(m = 25,\ \epsilon = 0.20)}$	= 1.316

TABLE A15

One-Sided Air-to-Ground Acquisition Advantages

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	0	1	1	1	0	0	0	1	0	4
Low	0	1	0	0	2	0	0	0	—	3

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 8
Sample variance – high tactic s_1^2	= 0.247
Sample variance – low tactic s_2^2	= 0.415
Pooled estimate of variance $\hat{\sigma}^2$	= 0.370
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.295
Student's t	= 0.234
Tabular $t_{(m = 15,\ \epsilon = 0.80)}$	= 0.257
Tabular $t_{(m = 15,\ \epsilon = 0.90)}$	= 0.127

TABLE A16

One-Sided Air-to-Ground Acquisition Advantages

(High compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
High	0	1	1	1	0	0	0	1	0	—	4
Low, dismount and/or pop-up	2	1	1	3	1	3	2	1	2	2	18

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high tactic s_1^2	= 0.247
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.560
Pooled estimate of variance $\hat{\sigma}^2$	= 0.460
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.311
Student's t	= 4.360
Tabular $t_{(m = 17,\ \epsilon = 0.001)}$	= 3.965

TABLE A17

One-Sided Air-to-Ground Acquisition Advantages

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Low	0	1	0	0	2	0	0	0	—	—	3
Low, dismount and/or pop-up	2	1	1	3	1	3	2	1	2	2	18

Observations – low tactic n_1	= 8
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – low tactic s_1^2	= 0.415
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.560
Pooled estimate of variance $\hat{\sigma}^2$	= 0.558
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.354
Student's t	= 4.025
Tabular $t_{(m = 16,\ \epsilon = 0.001)}$	= 4.015

TABLE A18

One-Sided Air-to-Ground Acquisition Advantages

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
	Advantages																	
High, low	0	0	1	1	1	0	0	1	2	0	0	0	0	0	1	0	0	7
Low, dismount and/or pop-up	2	1	1	3	1	3	2	1	2	2	—	—	—	—	—	—	—	18

Observations – high, low tactics n_1	= 17
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high, low tactics s_1^2	= 0.359
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.560
Pooled estimate of variance $\hat{\sigma}^2$	= 0.468
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.273
Student's t	= 5.084
Tabular $t_{(m = 25,\ \epsilon = 0.001)}$	= 3.725

TABLE A19

One-Sided Air-to-Ground Acquisition Advantages

(Moving compared with dispersed ground employment)

Employment	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Moving	2	0	1	2	—	—	—	—	—	—	5
Dispersed	0	0	1	1	1	0	0	1	2	0	6

Observations – moving elements n_1	= 4
Observations – dispersed elements n_2	= 10
Sample variance – moving elements s_1^2	= 0.688
Sample variance – dispersed elements s_2^2	= 0.440
Pooled estimate of variance $\hat{\sigma}^2$	= 0.596
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.457
Student's t	= 1.422
Tabular $t_{(m = 12,\ \epsilon = 0.20)}$	= 1.356
Tabular $t_{(m = 12,\ \epsilon = 0.10)}$	= 1.782

TABLE A20

One-Sided Air-to-Ground Acquisition Advantages

(Moving compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Moving	2	0	1	2	—	—	—	—	—	—	—	—	—	5
Concentrated	0	2	0	1	0	1	0	3	1	3	1	0	2	14

Observations – moving elements n_1	= 4
Observations – concentrated elements n_2	= 13
Sample variance – moving elements s_1^2	= 0.688
Sample variance – concentrated elements s_2^2	= 1.150
Pooled estimate of variance $\hat{\sigma}^2$	= 1.180
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.620
Student's t	= 0.281
Tabular $t_{(m = 15,\ \epsilon = 0.70)}$	= 0.393
Tabular $t_{(m = 15,\ \epsilon = 0.80)}$	= 0.258

TABLE A21

One-Sided Air-to-Ground Acquisition Advantages

(Dispersed compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Dispersed	0	0	1	1	1	0	0	1	2	0	—	—	—	6
Concentrated	0	2	0	1	0	1	0	3	1	3	1	0	2	14

Observations – dispersed elements n_1	= 10
Observations – concentrated elements n_2	= 13
Sample variance – dispersed elements s_1^2	= 0.440
Sample variance – concentrated elements s_2^2	= 1.150
Pooled estimate of variance $\hat{\sigma}^2$	= 0.921
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.402
Student's t	= 1.184
Tabular $t_{(m = 21,\ \epsilon = 0.30)}$	= 1.063
Tabular $t_{(m = 21,\ \epsilon = 0.20)}$	= 1.323

TABLE A22

One-Sided Air-to-Ground Acquisition Advantages

(Moving compared with dispersed, concentrated ground employment)

Employment	Observation																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	Advantages																							
Moving	2	0	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
Dispersed, concentrated	0	0	1	1	1	0	0	1	2	0	0	2	0	1	0	1	0	3	1	3	1	0	2	20

Observations – moving elements n_1	= 4
Observations – dispersed, concentrated elements n_2	= 23
Sample variance – moving elements s_1^2	= 0.688
Sample variance – dispersed, concentrated elements s_2^2	= 0.895
Pooled estimate of variance $\hat{\sigma}^2$	= 0.933
Best estimate of standard error of difference $\hat{\sigma}_{u'}$	= 0.523
Student's t	= 0.727
Tabular $t_{(m = 25,\ \epsilon = 0.50)}$	= 0.684
Tabular $t_{(m = 25,\ \epsilon = 0.40)}$	= 0.856

TABLE A23

One-Sided Air-to-Ground Acquisition Advantages

(Comparison of ground elements)

Ground element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Tank	22	6	4.250	0.721
Jeep	34	4	6.600	1.024
Moving jeep	18	2	3.500	0.643
APC	20	5	3.875	0.326
Moving APC	19	6	3.675	1.471
Infantry	16	2	3.100	0.390
Total	129	25	25.000	4.575

$$\chi^2_{(m = 5,\ \epsilon = 0.50)} = 4.351$$

$$\chi^2_{(m = 5,\ \epsilon = 0.30)} = 6.064$$

TABLE A24

One-Sided Air-to-Ground Acquisition Advantages

(Moving compared with stationary employment)

Employment	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Moving	37	8	7.175	0.094
Stationary	92	17	17.825	0.038
Total	129	25	25.000	0.132

$$\chi^2_{(m = 1,\ \epsilon = 0.80)} = 0.064$$

$$\chi^2_{(m = 1,\ \epsilon = 0.70)} = 0.148$$

TABLE A25

One-Sided Air-to-Ground Acquisition Advantages

(Large compared with small ground elements)

Size	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Large	61	17	11.825	2.265
Small	68	8	13.175	2.033
Total	129	25	25.000	4.298

$$\chi^2_{(m = 1,\ \epsilon = 0.05)} = 3.841$$

$$\chi^2_{(m = 1,\ \epsilon = 0.02)} = 5.412$$

TABLE A26

One-Sided Air-to-Ground Acquisition Advantages

(APCs compared with other ground elements)

Element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
APC	39	11	7.550	1.576
Others	90	14	17.450	0.682
Total	129	25	25.000	2.258

$$\chi^2_{(m=1,\ \epsilon=0.20)} = 1.642$$

$$\chi^2_{(m=1,\ \epsilon=0.10)} = 2.706$$

TABLE A27

Interacquisition Advantages

(Ground compared with air)

Side	Run																											
	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	4-1	4-2	4-3	4-4	4-5	4-6	5-1	5-2	5-3	5-4	5-5	Total
	Advantages																											
Ground	1	3	1	0	2	2	2	1	2	2	2	1	2	0	1	2	0	0	0	0	1	2	0	1	0	0	0	28
Air	1	0	1	0	0	1	0	0	0	2	0	0	0	1	0	2	1	0	0	0	0	1	1	1	0	0	0	12
Difference x	0	3	0	0	2	1	2	1	2	0	2	1	2	−1	1	0	−1	0	0	0	1	1	−1	0	0	0	0	16

Average difference $\bar{x}$ = 0.593

Sample variance s^2 = 0.815

Student's t = 3.347

Tabular $t_{(m=26,\ \epsilon=0.01)}$ = 2.779

Tabular $t_{(m=26,\ \epsilon=0.001)}$ = 3.707

TABLE A28

Ground-to-Air Interacquisition Advantages

(One compared with two helicopters)

Helicopters used	Observation														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
	Advantages														
1	1	2	2	1	2	2	2	1	0	0	2	0	0	0	15
2	3	1	0	2	2	1	0	2	0	0	1	1	0	—	13

Observations – one helicopter n_1	= 14
Observations – two helicopters n_2	= 13
Sample variance – one helicopter s_1^2	= 0.781
Sample variance – two helicopters s_2^2	= 0.923
Pooled estimate of variance $\hat{\sigma}^2$	= 0.917
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.369
Student's t	= 0.194
Tabular $t_{(m = 25,\ \epsilon = 0.80)}$	= 0.256
Tabular $t_{(m = 25,\ \epsilon = 0.90)}$	= 0.127

TABLE A29

Ground-to-Air Interacquisition Advantages

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	1	1	2	1	2	1	0	1	2	11
Low	3	0	2	2	2	2	2	1	—	14

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 8
Sample variance – high tactic s_1^2	= 0.396
Sample variance – low tactic s_2^2	= 0.688
Pooled estimate of variance $\hat{\sigma}^2$	= 0.604
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.378
Student's t	= 1.398
Tabular $t_{(m = 15,\ \epsilon = 0.20)}$	= 1.341
Tabular $t_{(m = 15,\ \epsilon = 0.10)}$	= 1.753

TABLE A30

Ground-to-Air Interacquisition Advantages

(High compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
High	1	1	2	1	2	1	0	1	2	—	11
Low, dismount and/or pop-up	1	0	2	0	0	0	0	0	0	0	3

Observations – high tactic n_1	= 9
Observations - low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high tactic s_1^2	= 0.396
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.410
Pooled estimate of variance $\hat{\sigma}^2$	= 0.451
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.309
Student's t	= 2.989
Tabular $t_{(m = 17,\ \epsilon = 0.01)}$	= 2.898
Tabular $t_{(m = 17,\ \epsilon = 0.001)}$	= 3.965

TABLE A31

Ground-to-Air Interacquisition Advantages

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Low	3	0	2	2	2	2	2	1	—	—	14
Low, dismount and/or pop-up	1	0	2	0	0	0	0	0	0	0	3

Observations – low tactic n_1	= 8
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – low tactic s_1^2	= 0.688
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.410
Pooled estimate of variance $\hat{\sigma}^2$	= 0.600
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.368
Student's t	= 3.945
Tabular $t_{(m = 16,\ \epsilon = 0.01)}$	= 2.921
Tabular $t_{(m = 16,\ \epsilon = 0.001)}$	= 4.015

TABLE A32

Ground-to-Air Interacquisition Advantages

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
	Advantages																	
High, low	1	3	1	0	2	2	2	1	2	2	2	2	1	0	1	2	1	25
Low, dismount and/or pop-up	1	0	2	0	0	0	0	0	0	0	—	—	—	—	—	—	—	3

Observations – high, low tactics n_1	= 17
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high, low tactics s_1^2	= 0.602
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.410
Pooled estimate of variance $\hat{\sigma}^2$	= 0.573
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.302
Student's t	= 3.881
Tabular $t_{(m = 25,\ \epsilon = 0.001)}$	= 3.725

TABLE A33

Ground-to-Air Interacquisition Advantages

(Moving compared with dispersed ground employment)

Employment	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Moving	0	1	0	0	—	—	—	—	—	—	1
Dispersed	1	3	1	0	2	2	2	1	2	2	16

Observations – moving elements n_1	= 4
Observations – dispersed elements n_2	= 10
Sample variance – moving elements s_1^2	= 0.188
Sample variance – dispersed elements s_2^2	= 0.640
Pooled estimate of variance $\hat{\sigma}^2$	= 0.596
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.457
Student's t	= 2.956
Tabular $t_{(m = 12,\ \epsilon = 0.02)}$	= 2.681
Tabular $t_{(m = 12,\ \epsilon = 0.01)}$	= 3.055

TABLE A34

Ground-to-Air Interacquisition Advantages

(Moving compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Moving	0	1	0	0	—	—	—	—	—	—	—	—	—	1
Concentrated	2	1	2	0	1	2	0	0	0	0	1	2	0	11

Observations – moving elements n_1 = 4

Observations – concentrated elements n_2 = 13

Sample variance – moving elements s_1^2 = 0.188

Sample variance – concentrated elements s_2^2 = 0.746

Pooled estimate of variance $\hat{\sigma}^2$ = 0.696

Best estimate of standard error of difference $\hat{\sigma}_w$ = 0.477

Student's t = 1.249

Tabular $t_{(m = 15,\ \epsilon = 0.30)}$ = 1.074

Tabular $t_{(m = 15,\ \epsilon = 0.20)}$ = 1.341

TABLE A35

Ground-to-Air Interacquisition Advantages

(Dispersed compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Dispersed	1	3	1	0	2	2	2	1	2	2	—	—	—	16
Concentrated	2	1	2	0	1	2	0	0	0	0	1	2	0	11

Observations – dispersed elements n_1 = 10

Observations – concentrated elements n_2 = 13

Sample variance – dispersed elements s_1^2 = 0.640

Sample variance – concentrated elements s_2^2 = 0.746

Pooled estimate of variance $\hat{\sigma}^2$ = 0.766

Best estimate of standard error of difference $\hat{\sigma}_w$ = 0.368

Student's t = 2.048

Tabular $t_{(m = 21,\ \epsilon = 0.10)}$ = 1.721

Tabular $t_{(m = 21,\ \epsilon = 0.05)}$ = 2.080

TABLE A36

Ground-to-Air Interacquisition Advantages

(Moving compared with dispersed, concentrated ground employment)

Employment	Observation																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	Advantages																							
Moving	0	1	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Dispersed, concentrated	1	3	1	0	2	2	2	1	2	2	2	1	2	0	1	2	0	0	0	0	1	2	0	27

Observations – moving elements	n_1	= 4
Observations – dispersed, concentrated elements	n_2	= 23
Sample variance – moving elements	s_1^2	= 0.188
Sample variance – dispersed, concentrated elements	s_2^2	= 0.839
Pooled estimate of variance	$\hat{\partial}^2$	= 0.802
Best estimate of standard error of difference	$\hat{\sigma}_w$	= 0.485
Student's t		= 1.904
Tabular	$t_{(m = 25,\ \epsilon = 0.10)}$	= 1.708
Tabular	$t_{(m = 25,\ \epsilon = 0.05)}$	= 2.060

TABLE A37

Ground-to-Air Interacquisition Advantages

(Comparison of ground elements)

Ground element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Tank	22	11	4.775	8.115
Jeep	34	6	7.380	0.258
Moving jeep	18	2	3.907	0.931
APC	20	2	4.341	1.262
Moving APC	19	3	4.124	0.306
Infantry	16	4	3.473	0.080
Total	129	28	28.000	10.952

$$\chi^2_{(m = 5,\ \epsilon = 0.10)} = 9.236$$

$$\chi^2_{(m = 5,\ \epsilon = 0.05)} = 11.070$$

TABLE A38

Ground-to-Air Interacquisition Advantages

(Moving compared with stationary employment)

Employment	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Moving	37	5	8.031	1.144
Stationary	92	23	19.969	0.460
Total	129	28	28.000	1.604

$$\chi^2_{(m = 1,\ \epsilon = 0.30)} = 1.074$$

$$\chi^2_{(m = 1,\ \epsilon = 0.20)} = 1.642$$

TABLE A39

Ground-to-Air Interacquisition Advantages

(Large compared with small ground elements)

Size	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Large	61	16	13.240	0.575
Small	68	12	14.760	0.516
Total	129	28	28.000	1.091

$$\chi^2_{(m = 1,\ \epsilon = 0.30)} = 1.074$$

$$\chi^2_{(m = 1,\ \epsilon = 0.20)} = 1.642$$

TABLE A40

Air-to-Ground Interacquisition Advantages

(One compared with two helicopters)

Helicopters used	Observation														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
	Advantages														
1	1	0	0	0	0	0	0	0	1	0	1	1	0	0	4
2	0	1	0	1	2	0	1	2	0	0	0	1	0	—	8

Observations – one helicopter n_1	= 14
Observations – two helicopters n_2	= 13
Sample variance – one helicopter s_1^2	= 0.204
Sample variance – two helicopters s_2^2	= 0.544
Pooled estimate of variance $\hat{\sigma}^2$	= 0.397
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.243
Student's t	= 1.358
Tabular $t_{(m = 25,\ \epsilon = 0.20)}$	= 1.316
Tabular $t_{(m = 25,\ \epsilon = 0.10)}$	= 1.708

TABLE A41

Air-to-Ground Interacquisition Advantages

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	1	1	0	0	2	0	1	0	1	6
Low	0	0	1	0	0	0	0	1	—	2

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 8
Sample variance – high tactic s_1^2	= 0.444
Sample variance – low tactic s_2^2	= 0.188
Pooled estimate of variance $\hat{\sigma}^2$	= 0.367
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.294
Student's t	= 1.416
Tabular $t_{(m = 15,\ \epsilon = 0.20)}$	= 1.341
Tabular $t_{(m = 15,\ \epsilon = 0.10)}$	= 1.753

TABLE A42

Air-to-Ground Interacquisition Advantages

(High compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
High	1	1	0	0	2	0	1	0	1	—	6
Low, dismount and/or pop-up	0	1	2	0	0	0	1	0	0	0	4

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high tactic s_1^2	= 0.444
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.440
Pooled estimate of variance $\hat{\sigma}^2$	= 0.494
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.323
Student's t	= 0.826
Tabular $t_{(m = 17,\ \epsilon = 0.50)}$	= 0.689
Tabular $t_{(m = 17,\ \epsilon = 0.40)}$	= 0.863

TABLE A43

Air-to-Ground Interacquisition Advantages

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Low	0	0	1	0	0	0	0	1	—	—	2
Low, dismount and/or pop-up	0	1	2	0	0	0	1	0	0	0	4

Observations – low tactic n_1	= 8
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – low tactic s_1^2	= 0.188
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.440
Pooled estimate of variance $\hat{\sigma}^2$	= 0.369
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.288
Student's t	= 0.521
Tabular $t_{(m = 16,\ \epsilon = 0.60)}$	= 0.535
Tabular $t_{(m = 16,\ \epsilon = 0.70)}$	= 0.392

TABLE A44

Air-to-Ground Interacquisition Advantages

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
	Advantages																	
High, low	1	0	1	0	0	1	0	0	0	2	0	0	0	1	0	1	1	8
Low, dismount and/or pop-up	0	1	2	0	0	0	1	0	0	0	—	—	—	—	—	—	—	4

Observations – high, low tactics n_1	= 17
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high, low tactics s_1^2	= 0.367
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.440
Pooled estimate of variance $\hat{\sigma}^2$	= 0.425
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.260
Student's t	= 0.272
Tabular $t_{(m = 25,\ \epsilon = 0.70)}$	= 0.390
Tabular $t_{(m = 25,\ \epsilon = 0.80)}$	= 0.256

TABLE A45

Air-to-Ground Interacquisition Advantages

(Moving compared with dispersed ground employment)

Employment	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Moving	1	1	0	0	—	—	—	—	—	—	2
Dispersed	1	0	1	0	0	1	0	0	0	2	5

Observations – moving elements n_1	= 4
Observations – dispersed elements n_2	= 10
Sample variance – moving elements s_1^2	= 0.250
Sample variance – dispersed elements s_2^2	= 0.450
Pooled estimate of variance $\hat{\sigma}^2$	= 0.458
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.401
Student's t	= 0

TABLE A46

Air-to-Ground Interacquisition Advantages

(Moving compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Moving	1	1	0	0	—	—	—	—	—	—	—	—	—	2
Concentrated	0	0	0	1	0	2	1	0	0	0	0	1	0	5

Observations – moving elements n_1	= 4
Observations – concentrated elements n_2	= 13
Sample variance – moving elements s_1^2	= 0.250
Semple variance – concentrated elements s_2^2	= 0.391
Pooled estimate of variance $\hat{\sigma}^2$	= 0.405
Best estimate of st ndard error of difference $\hat{\sigma}_w$	= 0.364
Student's t	= 0.317
Tabular $t_{(m = 15,\ \epsilon = 0.70)}$	= 0.393
Tabular $t_{(m = 15,\ \epsilon = 0.80)}$	= 0.258

TABLE A47

Air-to-Ground Interacquisition Advantages

(Dispersed compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Dispersed	1	0	1	0	0	1	0	0	0	2	—	—	—	5
Concentrated	0	0	0	1	0	2	1	0	0	0	0	1	0	5

Observations – dispersed elements n_1	= 10
Observations – concentrated elements n_2	= 13
Sample variance – dispersed elements s_1^2	= 0.450
Sample variance – concentrated elements s_2^2	= 0.391
Pooled estimate of variance $\hat{\sigma}^2$	= 0.456
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.284
Student's t	= 0.406
Tabular $t_{(m = 21,\ \epsilon = 0.60)}$	= 0.532
Tabular $t_{(m = 21,\ \epsilon = 0.70)}$	= 0.391

TABLE A48

Air-to-Ground Interacquisition Advantages

(Moving compared with dispersed, concentrated ground employment)

Employment	Observation																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	Advantages																							
Moving	1	1	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Dispersed, concentrated	1	0	1	0	0	1	0	0	0	2	0	0	0	1	0	2	1	0	0	0	0	1	0	10

Observations – moving elements	n_1	= 4
Observations – dispersed, concentrated elements	n_2	= 23
Sample variance – moving elements	s_1^2	= 0.250
Sample variance – dispersed, concentrated elements	s_2^2	= 0.420
Pooled estimate of variance	$\hat{\sigma}^2$	= 0.426
Best estimate of standard error of difference	$\hat{\sigma}_w$	= 0.354
Student's t		= 0.184
Tabular $t_{(m = 25,\ \epsilon = 0.80)}$		= 0.256
Tabular $t_{(m = 25,\ \epsilon = 0.90)}$		= 0.127

TABLE A49

Air-to-Ground Interacquisition Advantages

(Comparison of ground elements)

Ground element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Tank	22	1	2.047	0.536
Jeep	34	1	3.163	1.479
Moving jeep	18	1	1.674	0.271
APC	20	4	1.860	2.462
Moving APC	19	4	1.767	2.822
Infantry	16	1	1.489	0.161
Total	129	12	12.000	7.731

$$\chi^2_{(m = 5,\ \epsilon = 0.20)} = 7.289$$

$$\chi^2_{(m = 5,\ \epsilon = 0.10)} = 9.236$$

TABLE A50

Air-to-Ground Interacquisition Advantages

(Moving compared with stationary employment)

Employment	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Moving	37	5	3.442	0.705
Stationary	92	7	8.558	0.284
Total	129	12	12.000	0.989

$$\chi^2_{(m = 1,\ \epsilon = 0.50)} = 0.455$$

$$\chi^2_{(m = 1,\ \epsilon = 0.30)} = 1.074$$

TABLE A51

Air-to-Ground Interacquisition Advantages

(Large compared with small ground elements)

Size	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Large	61	9	5.674	1.950
Small	68	3	6.326	1.749
Total	129	12	12.000	3.699

$$\chi^2_{(m = 1,\ \epsilon = 0.10)} = 2.706$$

$$\chi^2_{(m = 1,\ \epsilon = 0.05)} = 3.841$$

TABLE A52

Air-to-Ground Interacquisition Advantages

(APCs compared with other ground elements)

Element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
APC	39	8	3.628	5.269
Others	90	4	8.372	2.283
Total	129	12	12.000	7.552

$$\chi^2_{(m = 1,\ \epsilon = 0.01)} = 6.635$$

$$\chi^2_{(m = 1,\ \epsilon = 0.001)} = 10.827$$

TABLE A53

Overall Acquisition Advantages

(Ground compared with air)

Side	Run																											
	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	4-1	4-2	4-3	4-4	4-5	4-6	5-1	5-2	5-3	5-4	5-5	Total
	Advantages																											
Ground	5	6	12	8	9	13	6	4	5	11	5	4	9	8	12	7	2	0	3	2	9	7	0	3	2	4	0	156
Air	1	0	2	1	1	1	0	1	2	2	0	2	0	2	0	3	1	3	1	3	1	1	3	1	1	2	2	37
Difference x	4	6	10	7	8	12	6	3	3	9	5	2	9	6	12	4	1	−3	2	−1	8	6	−3	2	1	2	−2	119

Average difference $\bar{x}$ = 4.407

Sample variance s^2 = 17.130

Student's t = 5.429

Tabular $t_{(m = 26,\ \epsilon = 0.001)}$ = 3.707

TABLE A54

Overall Ground-to-Air Acquisition Advantages

(One compared with two helicopters)

Helicopters used	Observation														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
	Advantages														
1	5	9	6	4	5	5	9	12	2	3	7	0	2	4	73
2	6	12	8	13	11	4	8	7	0	2	9	3	0	—	83

Observations – one helicopter n_1	= 14
Observations – two helicopters n_2	= 13
Sample variance – one helicopter s_1^2	= 9.597
Sample variance – two helicopters s_2^2	= 17.463
Pooled estimate of variance $\hat{\sigma}^2$	= 14.455
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.464
Student's t	= 0.799
Tabular $t_{(m = 25,\ \epsilon = 0.40)}$	= 0.856
Tabular $t_{(m = 25,\ \epsilon = 0.50)}$	= 0.684

TABLE A55

Overall Ground-to-Air Acquisition Advantages

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	5	12	9	4	11	12	2	9	7	71
Low	6	8	13	6	5	5	9	3	—	55

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 8
Sample variance – high tactic s_1^2	= 11.653
Sample variance – low tactic s_2^2	= 8.359
Pooled estimate of variance $\hat{\sigma}^2$	= 11.450
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.645
Student's t	= 0.616
Tabular $t_{(m = 15,\ \epsilon = 0.50)}$	= 0.691
Tabular $t_{(m = 15,\ \epsilon = 0.60)}$	= 0.536

TABLE A56

Overall Ground-to-Air Acquisition Advantages

(High compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
High	5	12	9	4	11	12	2	9	7	—	71
Low, dismount and/or pop-up	4	8	7	0	3	2	0	2	4	0	30

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high tactic s_1^2	= 11.653
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 7.200
Pooled estimate of variance $\hat{\sigma}^2$	= 10.405
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.482
Student's t	= 3.299
Tabular $t_{(m = 17,\ \epsilon = 0.01)}$	= 2.898
Tabular $t_{(m = 17,\ \epsilon = 0.001)}$	= 3.965

TABLE A57

Overall Ground-to-Air Acquisition Advantages

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Low	6	8	13	6	5	5	9	3	—	—	55
Low, dismount and/or pop-up	4	8	7	0	3	2	0	2	4	0	30

Observations – low tactic n_1	= 8
Observations – low, dismount and or pop-up tactic n_2	= 10
Sample variance – low tactic s_1^2	= 8.359
Sample variance – low, dismount and or pop-up tactic s_2^2	= 7.200
Pooled estimate of variance $\hat{\sigma}^2$	= 8.680
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.398
Student's t	= 2.773
Tabular $t_{(m = 16,\ \epsilon = 0.02)}$	= 2.583
Tabular $t_{(m = 16,\ \epsilon = 0.01)}$	= 2.921

TABLE A58

Overall Ground-to-Air Acquisition Advantages

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
	Advantages																	
High, low	5	6	12	8	9	13	6	4	5	11	5	9	12	2	9	7	3	126
Low, dismount and/or pop-up	4	8	7	0	3	2	0	2	4	0	—	—	—	—	—	—	—	30

Observations – high, low tactics n_1	= 17
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high, low tactics s_1^2	= 10.359
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 7.200
Pooled estimate of variance $\hat{\sigma}^2$	= 9.924
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.255
Student's t	= 3.514
Tabular $t_{(m = 25,\ \epsilon = 0.01)}$	= 2.787
Tabular $t_{(m = 25,\ \epsilon = 0.001)}$	= 3.725

TABLE A59

Overall Ground-to-Air Acquisition Advantages

(Moving compared with dispersed ground employment)

Employment	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Moving	0	3	2	0	—	—	—	—	—	—	5
Dispersed	5	6	12	8	9	13	6	4	5	11	79

Observations – moving elements n_1	= 4
Observations – dispersed elements n_2	= 10
Sample variance – moving elements s_1^2	= 1.688
Sample variance – dispersed elements s_2^2	= 9.290
Pooled estimate of variance $\hat{\sigma}^2$	= 8.304
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.705
Student's t	= 3.901
Tabular $t_{(m = 12,\ \epsilon = 0.01)}$	= 3.055
Tabular $t_{(m = 12,\ \epsilon = 0.001)}$	= 4.318

TABLE A60

Overall Ground-to-Air Acquisition Advantages

(Moving compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Moving	0	3	2	0	—	—	—	—	—	—	—	—	—	5
Concentrated	5	4	9	8	12	7	2	0	3	2	9	7	4	72

Observations – moving elements n_1	= 4
Observations – concentrated elements n_2	= 13
Sample variance – moving elements s_1^2	= 1.688
Sample variance – concentrated elements s_2^2	= 11.017
Pooled estimate of variance $\hat{\sigma}^2$	9.998
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.808
Student's t	= 2.372
Tabular $t_{(m = 15,\ \epsilon = 0.05)}$	= 2.131
Tabular $t_{(m = 15,\ \epsilon = 0.02)}$	= 2.602

TABLE A61

Overall Ground-to-Air Acquisition Advantages

(Dispersed compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Dispersed	5	6	12	8	9	13	6	4	5	11	—	—	—	79
Concentrated	5	4	9	8	12	7	2	0	3	2	9	7	4	72

Observations – dispersed elements n_1	= 10
Observations – concentrated elements n_2	= 13
Sample variance – dispersed elements s_1^2	= 9.290
Sample variance – concentrated elements s_2^2	= 11.017
Pooled estimate of variance $\hat{\sigma}^2$	= 11.244
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.410
Student's t	= 1.674
Tabular $t_{(m = 21,\ \epsilon = 0.20)}$	= 1.323
Tabular $t_{(m = 21,\ \epsilon = 0.10)}$	= 1.721

TABLE A62

Overall Ground-to-Air Acquisition Advantages

(Moving compared with dispersed, concentrated ground employment)

Employment	Observation																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	Advantages																							
Moving	0	3	2	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
Dispersed, concentrated	5	6	12	8	9	13	6	4	5	11	5	4	9	8	12	7	2	0	3	2	9	7	4	151

Observations – moving elements n_1	= 4
Observations – dispersed, concentrated elements n_2	= 23
Sample variance – moving elements s_1^2	= 1.688
Sample variance – dispersed, concentrated elements s_2^2	= 11.640
Pooled estimate of variance $\hat{\sigma}^2$	= 10.979
Best estimate of standard error of difference $\hat{\sigma}_{u'}$	= 1.795
Student's t	= 2.961
Tabular $t_{(m = 25,\ \epsilon = 0.01)}$	= 2.787
Tabular $t_{(m = 25,\ \epsilon = 0.001)}$	= 3.725

TABLE A63

Overall Ground-to-Air Acquisition Advantages

(Comparison of ground elements)

Ground element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Tank	22	30	26.605	0.433
Jeep	34	48	41.116	1.153
Moving jeep	18	21	21.767	0.027
APC	20	19	24.186	1.112
Moving APC	19	7	22.977	11.110
Infantry	16	31	19.349	7.015
Total	129	156	156.000	20.851

$\chi^2_{(m\ 5,\ \epsilon\ 0.001)}$ 20.517

TABLE A64

Overall Ground-to-Air Acquisition Advantages

(Moving compared with stationary employment)

Employmen	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Moving	37	28	44.744	6.266
Stationary	92	128	111.256	2.520
Total	129	156	156.000	8.786

$\chi^2_{(m\ 1,\ \epsilon\ 0.01)}$ 6.635

$\chi^2_{(m\ 1,\ \epsilon\ 0.001)}$ 10.827

TABLE A65

Overall Ground-to-Air Acquisition Advantages

(Large compared with small ground elements)

Size	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Large	61	56	73.767	4.279
Small	68	100	82.233	3.839
Total	129	156	156.000	8.118

$\chi^2_{(m\ -\ 1,\ \epsilon\ -\ 0.01)}$ 6.635

$\chi^2_{(m\ -\ 1,\ \epsilon\ -\ 0.001)}$ 10.827

TABLE A66

Overall Ground-to-Air Acquisition Advantages

(APCs compared with other ground elements)

Element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
APC	39	26	47.163	9.496
Others	90	130	108.837	4.115
Total	129	156	156.000	13.611

$$X^2_{(m=1,\ \epsilon\ 0.001)} \quad 10.827$$

TABLE A67

Overall Ground-to-Air Acquisition Advantages

(Infantry compared with other ground elements)

Element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Infantry	16	31	19.349	7.016
Others	113	125	136.651	0.993
Total	129	156	156.000	8.009

$$X^2_{(m\ \ 1,\ \epsilon\ \ 0.01)} - 6.635$$

$$X^2_{(m\ \ 1,\ \epsilon = 0.001)} - 10.827$$

TABLE A68

Overall Air-to-Ground Acquisition Advantages

(One compared with two helicopters)

Helicopters used	Observation														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
	Advantages														
1	1	1	0	1	2	0	0	0	1	1	1	3	1	2	14
2	0	2	1	1	2	2	2	3	3	3	1	1	2	—	23

Observations – one helicopter n_1	14
Observations – two helicopters n_2	13
Sample variance – one helicopter s_1^2	0.714
Sample variance – two helicopters s_2^2	0.793
Pooled estimate of variance $\hat{\sigma}^2$	0.812
Best estimate of standard error of difference $\hat{\sigma}_w$	0.347
Student's t	2.216
Tabular $t_{(m=25,\ \epsilon=0.05)}$	2.060
Tabular $t_{(m\ \ 25,\ \epsilon\ \ 0.02)}$	2.485

TABLE A69

Overall Air-to-Ground Acquisition Advantages

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	1	2	1	1	2	0	1	1	1	10
Low	0	1	1	0	2	0	0	1	—	5

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 8
Sample variance – high tactic s_1^2	= 0.322
Sample variance – low tactic s_2^2	= 0.484
Pooled estimate of variance $\hat{\sigma}^2$	= 0.452
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.327
Student's t	= 1.489
Tabular $t_{(m = 15,\ \epsilon = 0.20)}$	= 1.341
Tabular $t_{(m = 15,\ \epsilon = 0.10)}$	1.753

TABLE A70

Overall Air-to-Ground Acquisition Advantages

(High compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
High	1	2	1	1	2	0	1	1	1	—	10
Low, dismount and/or pop-up	2	2	3	3	1	3	3	1	2	2	22

Observations – high tactic n_1	= 9
Observations – low, dismount and or pop-up tactic n_2	= 10
Sample variance – high tactic s_1^2	= 0.322
Sample variance – low, dismount and or pop-up tactic s_2^2	= 0.560
Pooled estimate of variance $\hat{\sigma}^2$	= 0.500
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.324
Student's t	= 3.352
Tabular $t_{(m = 17,\ \epsilon = 0.01)}$	= 2.898
Tabular $t_{(m = 17,\ \epsilon = 0.001)}$	= 3.965

TABLE A71

Overall Air-to-Ground Acquisition Advantages

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Low	0	1	1	0	2	0	0	1	—	—	5
Low, dismount and or pop-up	2	2	3	3	1	3	3	1	2	2	22

Observations – low tactic n_1	= 8
Observations – low, dismount and or pop-up tactic n_2	= 10
Sample variance – low tactic s_1^2	= 0.484
Sample variance – low, dismount and or pop-up tactic s_2^2	= 0.560
Pooled estimate of variance $\hat{\sigma}^2$	0.592
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.365
Student's t	= 4.314
Tabular $t_{(m = 16,\ \epsilon = 0.001)}$	= 4.015

TABLE A72

Overall Air-to-Ground Acquisition Advantages

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
	Advantages																	
High, low	1	0	2	1	1	1	0	1	2	2	0	0	0	1	1	1	1	15
Low, dismount and or pop-up	2	2	3	3	1	3	3	1	2	2	—	—	—	—	—	—	—	22

Observations – high, low tactics n_1	= 17
Observations – low, dismount and or pop-up tactic n_2	= 10
Sample variance – high, low tactics s_1^2	= 0.457
Sample variance – low, dismount and or pop-up tactic s_2^2	= 0.560
Pooled estimate of variance $\hat{\sigma}^2$	= 0.535
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.291
Student's t	= 4.523
Tabular $t_{(m = 25,\ \epsilon = 0.001)}$	= 3.725

TABLE A73

Overall Air-to-Ground Acquisition Advantages

(Moving compared with dispersed ground employment)

Employment	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Advantages										
Moving	3	1	1	2	—	—	—	—	—	—	7
Dispersed	1	0	2	1	1	1	0	1	2	2	11

Observations – moving elements n_1	4
Observations – dispersed elements n_2	10
Sample variance – moving elements s_1^2	0.688
Sample variance – dispersed elements s_2^2	0.490
Pooled estimate of variance $\hat{\sigma}^2$	0.638
Best estimate of standard error of difference $\hat{\sigma}_w$	0.472
Student's t	1.376
Tabular $t_{(m = 12,\ \epsilon = 0.20)}$	1.356
Tabular $t_{(m = 12,\ \epsilon = 0.10)}$	1.782

TABLE A74

Overall Air-to-Ground Acquisition Advantages

(Moving compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Moving	3	1	1	2	—	—	—	—	—	—	—	—	—	7
Concentrated	0	2	0	2	0	3	1	3	1	3	1	1	2	19

Observations – moving elements n_1	4
Observations – concentrated elements n_2	13
Sample variance – moving elements s_1^2	0.688
Sample variance – concentrated elements s_2^2	1.172
Pooled estimate of variance $\hat{\sigma}^2$	1.199
Best estimate of standard error of difference $\hat{\sigma}_w$	0.626
Student's t	0.461
Tabular $t_{(m = 15,\ \epsilon = 0.60)}$	0.536
Tabular $t_{(m = 15,\ \epsilon = 0.70)}$	0.393

TABLE A75

Overall Air-to-Ground Acquisition Advantages

(Dispersed compared with concentrated ground employment)

Employment	Observation													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	Advantages													
Dispersed	1	0	2	1	1	1	0	1	2	2	—	—	—	11
Concentrated	0	2	0	2	0	3	1	3	1	3	1	1	2	19

Observations – dispersed elements n_1	10
Observations – concentrated elements n_2	13
Sample variance – dispersed elements s_1^2	0.490
Sample variance – concentrated elements s_2^2	1.172
Pooled estimate of variance $\hat{\sigma}^2$	0.959
Best estimate of standard error of difference $\hat{\sigma}_{\bar{w}}$	0.412
Student's t	0.878
Tabular $t_{(m = 21, \epsilon = 0.40)}$	0.859
Tabular $t_{(m = 21, \epsilon = 0.30)}$	1.064

TABLE A76

Overall Air-to-Ground Acquisition Advantages

(Moving compared with dispersed, concentrated ground employment)

Employment	Observation																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	Advantages																							
Moving	3	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
Dispersed, concentrated	1	0	2	1	1	1	0	1	2	2	0	2	0	2	0	3	1	3	1	3	1	1	2	30

Observations – moving elements	n_1	= 4
Observations – dispersed, concentrated elements	n_2	= 23
Sample variance – moving elements	s_1^2	= 0.688
Sample variance – dispersed, concentrated elements	s_2^2	= 0.908
Pooled estimate of variance	$\hat{\sigma}^2$	= 0.945
Best estimate of standard error of difference	$\hat{\sigma}_w$	= 0.527
Student's t		= 0.846
Tabular	$t_{(m = 25,\ \epsilon = 0.50)}$	= 0.684
Tabular	$t_{(m = 25,\ \epsilon = 0.40)}$	= 0.856

TABLE A77

Overall Air-to-Ground Acquisition Advantages

(Comparison of ground elements)

Ground element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Tank	22	7	6.310	0.075
Jeep	34	5	9.752	2.316
Moving jeep	18	3	5.163	0.906
APC	20	9	5.736	1.857
Moving APC	19	10	5.450	3.799
Infantry	16	3	4.589	0.550
Total	129	37	37.000	9.503

$\chi^2_{(m = 5,\ \epsilon = 0.10)} = 9.236$

$\chi^2_{(m = 5,\ \epsilon = 0.05)} = 11.070$

TABLE A78

Overall Air-to-Ground Acquisition Advantages

(Moving compared with stationary employment)

Employment	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Moving	37	13	10.612	0.537
Stationary	92	24	26.388	0.216
Total	129	37	37.000	0.753

$\chi^2_{(m = 1,\ \epsilon = 0.50)} = 0.455$

$\chi^2_{(m = 1,\ \epsilon = 0.30)} = 1.074$

TABLE A79

Overall Air-to-Ground Acquisition Advantages

(Large compared with small ground elements)

Size	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
Large	61	26	17.496	4.133
Small	68	11	19.504	3.708
Total	129	37	37.000	7.841

$\chi^2_{(m = 1,\ \epsilon = 0.01)} = 6.635$

$\chi^2_{(m = 1,\ \epsilon = 0.001)} = 10.827$

TABLE A80

Overall Air-to-Ground Acquisition Advantages

(APCs compared with other ground elements)

Element	Total employed	Advantages for total		$\frac{(O-E)^2}{E}$
		Observed	Expected	
APC	39	19	11.186	5.458
Others	90	18	25.814	2.365
Total	129	37	37.000	7.823

$\chi^2_{(m=1,\ \epsilon=0.01)} = 6.635$

$\chi^2_{(m=1,\ \epsilon=0.001)} = 10.827$

TABLE A81

Acquired Compared with Available Helicopters

(One compared with two helicopters)

Helicopters				$\frac{(O-E)^2}{E}$
Used	Available	Acquired		
		Observed	Expected	
1	66	56	46.063	2.144
2	126	78	87.937	1.123
Total	192	134	134.000	3.267

$\chi^2_{(m=1,\ \epsilon=0.10)} = 2.706$

$\chi^2_{(m=1,\ \epsilon=0.05)} = 3.841$

TABLE A82

Acquired Compared with Available Helicopters

(High compared with low tactic)

Tactic	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
High	59	54	49.923	0.333
Low	58	45	49.077	0.339
Total	117	99	99.000	0.672

$\chi^2_{(m=1,\ \epsilon=0.50)} = 0.455$

$\chi^2_{(m=1,\ \epsilon=0.30)} = 1.074$

TABLE A83

Acquired Compared with Available Helicopters

(High compared with low, dismount and/or pop-up tactic)

Tactic	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
High	59	54	39.187	5.599
Low, dismount and/or pop-up	75	35	49.813	4.405
Total	134	89	89.000	10.004

$$\chi^2_{(m = 1,\ \epsilon = 0.01)} = 6.635$$

$$\chi^2_{(m = 1,\ \epsilon = 0.001)} = 10.827$$

TABLE A84

Acquired Compared with Available Helicopters

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Low	58	45	34.887	2.932
Low, dismount and/or pop-up	75	35	45.113	2.267
Total	133	80	80.000	5.199

$$\chi^2_{(m = 1,\ \epsilon = 0.05)} = 3.841$$

$$\chi^2_{(m = 1,\ \epsilon = 0.02)} = 5.412$$

TABLE A85

Acquired Compared with Available Helicopters

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
High, low	117	99	81.656	3.684
Low, dismount and/or pop-up	75	35	52.344	5.748
Total	192	134	134.000	9.432

$$\chi^2_{(m = 1,\ \epsilon = 0.01)} = 6.635$$

$$\chi^2_{(m = 1,\ \epsilon = 0.001)} = 10.827$$

TABLE A86

Acquired Compared with Available Helicopters

(Moving compared with dispersed ground employment)

Employment	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Moving	26	7	18.571	7.210
Dispersed	72	63	51.429	2.604
Total	98	70	70.000	9.814

$$\chi^2_{(m = 1,\ \epsilon = 0.01)} = 6.635$$

$$\chi^2_{(m = 1,\ \epsilon = 0.001)} = 10.827$$

TABLE A87

Acquired Compared with Available Helicopters

(Moving compared with concentrated ground employment)

Employment	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Moving	26	7	15.383	4.569
Concentrated	94	64	55.617	1.264
Total	120	71	71.000	5.833

$$\chi^2_{(m = 1,\ \epsilon = 0.02)} = 5.412$$

$$\chi^2_{(m = 1,\ \epsilon = 0.01)} = 6.635$$

TABLE A88

Acquired Compared with Available Helicopters

(Dispersed compared with concentrated ground employment)

Employment	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Dispersed	72	63	55.084	1.138
Concentrated	94	64	71.916	0.871
Total	166	127	127.000	2.009

$$\chi^2_{(m = 1,\ \epsilon = 0.20)} = 1.642$$

$$\chi^2_{(m = 1,\ \epsilon = 0.10)} = 2.706$$

TABLE A89

Acquired Compared with Available Helicopters

(Moving compared with dispersed, concentrated ground employment)

Employment	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Moving	26	7	18.146	6.846
Dispersed, concentrated	166	127	115.854	1.072
Total	192	134	134.000	7.918

$$\chi^2_{(m = 1,\ \epsilon = 0.01)} = 6.635$$

$$\chi^2_{(m = 1,\ \epsilon = 0.001)} = 10.827$$

TABLE A90

Acquired Compared with Available Helicopters

(Comparison of ground elements)

Ground element	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Tank	33	27	23.031	0.684
Jeep	50	36	34.896	0.035
Moving jeep	27	17	18.844	0.180
APC	29	19	20.240	0.076
Moving APC	29	16	20.240	0.888
Infantry	24	19	16.749	0.303
Total	192	134	134.000	2.166

$$\chi^2_{(m = 5,\ \epsilon = 0.80)} = 2.343$$

$$\chi^2_{(m = 5,\ \epsilon = 0.90)} = 1.610$$

TABLE A91

Acquired Compared with Available Helicopters

(Moving compared with stationary employment)

Employment	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Moving	56	33	39.083	0.947
Stationary	136	101	94.917	0.390
Total	192	134	134.000	1.337

$$\chi^2_{(m = 1,\ \epsilon = 0.30)} = 1.074$$

$$\chi^2_{(m = 1,\ \epsilon = 0.20)} = 1.642$$

TABLE A92

Acquired Compared with Available Helicopters

(Large compared with small ground elements)

Size	Helicopters			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Large	91	62	63.510	0.036
Small	101	72	70.490	0.032
Total	192	134	134.000	0.068

$$\chi^2_{(m = 1,\ \epsilon = 0.70)} = 0.148$$

$$\chi^2_{(m = 1,\ \epsilon = 0.80)} = 0.064$$

TABLE A93

Acquired Compared with Available Ground Elements

(One compared with two helicopters)

Helicopters used	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
1	66	30	32.233	0.155
2	63	33	30.767	0.162
Total	129	63	63.000	0.317

$$\chi^2_{(m = 1,\ \epsilon = 0.50)} = 0.455$$

$$\chi^2_{(m = 1,\ \epsilon = 0.70)} = 0.148$$

TABLE A94

Acquired Compared with Available Ground Elements

(High compared with low tactic)

Tactic	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
High	44	21	21.205	0.002
Low	39	19	18.795	0.002
Total	83	40	40.000	0.004

$$\chi^2_{(m = 1,\ \epsilon = 0.95)} = 0.004$$

TABLE A95

Acquired Compared with Available Ground Elements

(High compared with low, dismount and/or pop-up tactic)

Tactic	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
High	44	21	21.511	0.012
Low, dismount and/or pop-up	46	23	22.489	0.012
Total	90	44	44.000	0.024

$$\chi^2_{(m = 1,\ \epsilon = 0.80)} = 0.064$$

$$\chi^2_{(m = 1,\ \epsilon = 0.90)} = 0.016$$

TABLE A96

Acquired Compared with Available Ground Elements

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Low	39	19	19.271	0.004
Low, dismount and/or pop-up	46	23	22.729	0.003
Total	85	42	42.000	0.007

$$\chi^2_{(m = 1,\ \epsilon = 0.90)} = 0.016$$

$$\chi^2_{(m = 1,\ \epsilon = 0.95)} = 0.004$$

TABLE A97

Acquired Compared with Available Ground Elements

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
High, low	83	40	40.535	0.007
Low, dismount and or pop-up	46	23	22.465	0.013
Total	129	63	63.000	0.020

$$\chi^2_{(m=1,\ \epsilon=0.80)} = 0.064$$

$$\chi^2_{(m=1,\ \epsilon=0.90)} = 0.016$$

TABLE A98

Acquired Compared with Available Ground Elements

(Moving compared with dispersed ground employment)

Employment	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Moving	17	8	8.892	0.090
Dispersed	48	26	25.108	0.032
Total	65	34	34.000	0.122

$$\chi^2_{(m=1,\ \epsilon=0.70)} = 0.148$$

$$\chi^2_{(m=1,\ \epsilon=0.80)} = 0.064$$

TABLE A99

Acquired Compared with Available Ground Elements

(Moving compared with concentrated ground employment)

Employment	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Moving	17	8	7.765	0.007
Concentrated	64	29	29.235	0.002
Total	81	37	37.000	0.009

$$\chi^2_{(m=1,\ \epsilon=0.90)} = 0.016$$

$$\chi^2_{(m=1,\ \epsilon=0.95)} = 0.004$$

TABLE A100

Acquired Compared with Available Ground Elements

(Dispersed compared with concentrated ground employment)

Employment	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Dispersed	48	26	23.572	0.250
Concentrated	64	29	31.428	0.188
Total	112	55	55.000	0.438

$$\chi^2_{(m-1,\ \epsilon=0.50)} = 0.455$$

$$\chi^2_{(m-1,\ \epsilon=0.70)} = 0.148$$

TABLE A101

Acquired Compared with Available Ground Elements

(Moving compared with dispersed, concentrated ground employment)

Employment	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Moving	17	8	8.302	0.011
Dispersed, concentrated	112	55	54.698	0.002
Total	129	63	63.000	0.013

$$\chi^2_{(m-1,\ \epsilon=0.90)} = 0.016$$

$$\chi^2_{(m-1,\ \epsilon=0.95)} = 0.004$$

TABLE A102

Acquired Compared with Available Ground Elements

(Comparison of ground elements)

Type	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Tank	22	19	10.744	6.344
Jeep	34	10	16.605	2.627
Moving jeep	18	5	8.791	1.635
APC	20	10	9.767	0.006
Moving APC	19	13	9.279	1.492
Infantry	16	6	7.814	0.421
Total	129	63	63.000	12.525

$$\chi^2_{(m=5,\ \epsilon=0.05)} = 11.070$$

$$\chi^2_{(m=5,\ \epsilon=0.02)} = 13.388$$

TABLE A103

Acquired Compared with Available Ground Elements

(Moving compared with stationary employment)

Employment	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Moving	37	18	18.070	0.001
Stationary	92	45	44.930	0.000
Total	129	63	63.000	0.001

$$\chi^2_{(m=1,\ \epsilon=0.98)} = 0.001$$

TABLE A104

Acquired Compared with Available Ground Elements

(Large compared with small ground elements)

Size	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Large	61	42	29.791	5.004
Small	68	21	33.209	4.489
Total	129	63	63.000	9.493

$$\chi^2_{(m=1,\ \epsilon=0.01)} = 6.635$$

$$\chi^2_{(m=1,\ \epsilon=0.001)} = 10.827$$

TABLE A105

Acquired Compared with Available Ground Elements

(Tanks compared with other ground elements)

Element	Ground elements			$\frac{(O-E)^2}{E}$
	Available	Acquired		
		Observed	Expected	
Tank	22	19	10.744	6.344
Others	107	44	52.256	1.304
Total	129	63	63.000	7.648

$$\chi^2_{(m=1,\ \epsilon=0.01)} = 6.635$$

$$\chi^2_{(m=1,\ \epsilon=0.001)} = 10.827$$

TABLE A106

One-Sided Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(Ground compared with air)

Side	Run																						
	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	4-1	4-2	4-3	4-4	4-5	4-6	5-4	Total
	Advantages																							
Ground	4	3	11	8	7	11	4	3	3	9	3	3	7	8	11	5	2	0	3	2	8	5	4	124
Air	0	0	1	1	1	0	0	1	2	0	0	2	0	1	0	1	0	3	1	3	1	0	2	20
Difference x	4	3	10	7	6	11	4	2	1	9	3	1	7	7	11	4	2	−3	2	−1	7	5	2	104

Average difference $\bar{x}$ = 4.522

Sample variance s^2 = 13.207

Student's t = 5.836

Tabular $t_{(m = 22,\ \epsilon = 0.001)}$ = 3.792

TABLE A107

One-Sided Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(One compared with two helicopters)

Helicopters used	Observation												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
	Advantages												
1	4	7	4	3	3	3	7	11	2	3	5	4	56
2	3	11	8	11	9	3	8	5	0	2	8	—	68

Observations – one helicopter n_1	= 12
Observations – two helicopters n_2	= 11
Sample variance – one helicopter s_1^2	= 5.889
Sample variance – two helicopters s_2^2	= 12.876
Pooled estimate of variance $\hat{\sigma}^2$	= 10.110
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.328
Student's t	= 1.141
Tabular $t_{(m = 21,\ \epsilon = 0.30)}$	= 1.063
Tabular $t_{(m = 21,\ \epsilon = 0.20)}$	= 1.323

TABLE A108

One-Sided Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	4	11	7	3	9	11	2	8	5	60
Low	3	8	11	1	3	3	7	—	—	39

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 7
Sample variance – high tactic s_1^2	= 10.000
Sample variance – low tactic s_2^2	= 8.531
Pooled estimate of variance $\hat{\sigma}^2$	= 10.694
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.648
Student's t	= 0.665
Tabular $t_{(m = 14,\ \epsilon = 0.50)}$	= 0.692
Tabular $t_{(m = 14,\ \epsilon = 0.60)}$	= 0.537

TABLE A109

One-Sided Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low, dismount and/or pop-up)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	4	11	7	3	9	11	2	8	5	60
Low, dismount and/or pop-up	3	8	5	0	3	2	4	—	—	25

Observations – high tactic n_1	= 9
Observations – low, dismount and or pop-up n_2	= 7
Sample variance – high tactic s_1^2	= 10.000
Sample variance – low, dismount and or pop-up s_2^2	= 5.389
Pooled estimate of variance $\hat{\sigma}^2$	= 9.123
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.522
Student's t	= 2.033
Tabular $t_{(m = 14,\ \epsilon = 0.10)}$	= 1.761
Tabular $t_{(m = 14,\ \epsilon = 0.05)}$	= 2.145

TABLE A110

One-Sided Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(Low compared with low, dismount and/or pop up tactic)

Tactic	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Low	3	8	11	4	3	3	7	39
Low, dismount and/or pop-up	3	8	5	0	3	2	4	25

Observations – low tactic n_1	= 7
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – low tactic s_1^2	= 8.531
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 5.389
Pooled estimate of variance $\hat{\sigma}^2$	= 8.119
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.523
Student's t	= 1.313
Tabular $t_{(m = 12,\ \epsilon = 0.30)}$	= 1.083
Tabular $t_{(m = 12,\ \epsilon = 0\ 20)}$	= 1.356

TABLE A111

One-Sided Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	Advantages																
High, low	4	3	11	8	7	11	4	3	3	9	3	7	11	2	8	5	99
Low, dismount and/or pop-up	3	8	5	0	3	2	4	—	—	—	—	—	—	—	—	—	25

Observations – high, low tactics n_1	= 16
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – high, low tactics s_1^2	= 9.652
Sample variance – low, dismount and or pop-up tactic s_2^2	= 5.388
Pooled estimate of variance $\hat{\sigma}^2$	= 9.150
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.371
Student's t	= 1.908
Tabular $t_{(m = 21,\ \epsilon = 0.10)}$	= 1.721
Tabular $t_{(m = 21,\ \epsilon = 0.05)}$	= 2.080

TABLE A112

One-Sided Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(One compared with two helicopters)

Helicopters used	Observation												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
	Advantages												
1	0	1	0	1	2	0	0	0	0	1	0	2	7
2	0	1	1	0	0	2	1	1	3	3	1	—	13

Observations – one helicopter n_1	= 12
Observations – two helicopters n_2	= 11
Sample variance – one helicopter s_1^2	= 0.576
Sample variance – two helicopters s_2^2	= 1.058
Pooled estimate of variance $\hat{\sigma}^2$	= 0.883
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.392
Student's t	= 1.525
Tabular $t_{(m = 21,\ \epsilon = 0.20)}$	= 1.323
Tabular $t_{(m = 21,\ \epsilon = 0.10)}$	= 1.721

TABLE A113

One-Sided Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	0	1	1	1	0	0	0	1	0	4
Low	0	1	0	0	2	0	0	—	—	3

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 7
Sample variance – high tactic s_1^2	= 0.247
Sample variance – low tactic s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.424
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.328
Student's t	= 0.048
Tabular $t_{(m = 14,\ \epsilon = 0.90)}$	= 0.128

TABLE A114

One-Sided Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low, dismount and/or pop-up)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	0	1	1	1	0	0	0	1	0	4
Low, dismount and/or pop-up	2	1	1	3	1	3	2	—	—	13

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up n_2	= 7
Sample variance – high tactic s_1^2	= 0.247
Sample variance – low, dismount and or pop-up s_2^2	= 0.695
Pooled estimate of variance $\hat{\sigma}^2$	= 0.506
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.358
Student's t	= 3.942
Tabular $t_{(m = 14,\ \epsilon = 0.05)}$	= 2.977
Tabular $t_{(m = 14,\ \epsilon = 0.02)}$	= 4.140

TABLE A115

One-Sided Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Low	0	1	0	0	2	0	0	3
Low, dismount and/or pop-up	2	1	1	3	1	3	2	13

Observations – low tactic n_1	= 7
Observations – low, dismount and or pop-up tactic n_2	= 7
Sample variance – low tactic s_1^2	= 0.531
Sample variance – low, dismount and or pop-up tactic s_2^2	= 0.695
Pooled estimate of variance $\hat{\sigma}^2$	= 0.715
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.452
Student's t	3.161
Tabular $t_{(m = 12,\ \epsilon = 0.10)}$	= 3.055
Tabular $t_{(m = 12,\ \epsilon = 0.05)}$	= 4.318

TABLE A116

One-Sided Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	Advantages																
High, low	0	0	1	1	1	0	0	1	2	0	0	0	0	0	1	0	7
Low, dismount and/or pop-up	2	1	1	3	1	3	2	—	—	—	—	—	—	—	—	—	13

Observations – high, low tactics n_1	= 16
Observations – low, dismount and or pop-up tactic n_2	= 7
Sample variance – high, low tactics s_1^2	= 0.371
Sample variance – low, dismount and or pop-up tactic s_2^2	= 0.695
Pooled estimate of variance $\hat{\sigma}^2$	= 0.514
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.325
Student's t	= 4.368
Tabular $t_{(m = 21,\ \epsilon = 0.001)}$	= 3.819

TABLE A117

Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(Ground compared with air)

Side	Run																						
	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	4-1	4-2	4-3	4-4	4-5	4-6	5-4	Total
	Advantages																							
Ground	1	3	1	0	2	2	2	1	2	2	2	1	2	0	1	2	0	0	0	0	1	2	0	27
Air	1	0	1	0	0	1	0	0	0	2	0	0	0	1	0	2	1	0	0	0	0	1	0	10
Difference x	0	3	0	0	2	1	2	1	2	0	2	1	2	-1	1	0	-1	0	0	0	1	1	0	17

Average difference $\bar{x}$ = 0.739

Sample variance s^2 = 1.062

Student's t = 3.363

Tabular $t_{(m = 22,\ \epsilon = 0.01)}$ = 2.819

Tabular $t_{(m = 22,\ \epsilon = 0.001)}$ = 3.792

TABLE A118

Ground-to-Air Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(One compared with two helicopters)

Helicopters used	Observation												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
	Advantages												
1	1	2	2	1	2	2	2	1	0	0	2	0	15
2	3	1	0	2	2	1	0	2	0	0	1	—	12

Observations – one helicopter n_1	12
Observations – two helicopters n_2	11
Sample variance – one helicopter s_1^2	0.688
Sample variance – two helicopters s_2^2	0.992
Pooled estimate of variance $\hat{\sigma}^2$	0.912
Best estimate of standard error of difference $\hat{\sigma}_w$	0.399
Student's t	0.399
Tabular $t_{(m-21,\ \epsilon\ 0.60)}$	0.532
Tabular $t_{(m-21,\ \epsilon=0.70)}$	0.391

TABLE A119

Ground-to-Air Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	1	1	2	1	2	1	0	1	2	11
Low	3	0	2	2	2	2	2	—	—	13

Observations – high tactic n_1	9
Observations – low tactic n_2	7
Sample variance – high tactic s_1^2	0.395
Sample variance – low tactic s_2^2	0.694
Pooled estimate of variance $\hat{\sigma}^2$	0.601
Best estimate of standard error of difference $\hat{\sigma}_w$	0.391
Student's t	1.626
Tabular $t_{(m-14,\ \epsilon\ 0.20)}$	1.345
Tabular $t_{(m-14,\ \epsilon=0.10)}$	1.761

TABLE A120

Ground-to-Air Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low, dismount and/or pop-up)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	1	1	2	1	2	1	0	1	2	11
Low, dismount and/or pop-up	1	0	2	0	0	0	0	—	—	3

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – high tactic s_1^2	= 0.395
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.519
Best estimate of standard error of difference $\hat{\sigma}_w$	0.363
Student's t	= 2.185
Tabular $t_{(m = 14,\ \epsilon = 0.05)}$	= 2.145
Tabular $t_{(m = 14,\ \epsilon = 0.02)}$	= 2.624

TABLE A121

Ground-to-Air Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Low	3	0	2	2	2	2	2	13
Low, dismount and/or pop-up	1	0	2	0	0	0	0	3

Observations – low tactic n_1	= 7
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – low tactic s_1^2	= 0.694
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.714
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.452
Student's t	= 3.162
Tabular $t_{(m = 12,\ \epsilon = 0.01)}$	= 3.055
Tabular $t_{(m = 12,\ \epsilon = 0.001)}$	= 4.318

TABLE A122

Ground-to-Air Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	Advantages																
High, low	1	3	1	0	2	2	2	1	2	2	2	2	1	0	1	2	24
Low, dismount and/or pop-up	1	0	2	0	0	0	0	—	—	—	—	—	—	—	—	—	3

Observations – high, low tactics n_1	= 16
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – high, low tactics s_1^2	0.625
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.653
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.366
Student's t	= 2.925
Tabular $t_{(m = 21,\ \epsilon = 0.01)}$	= 2.831
Tabular $t_{(m = 21,\ \epsilon = 0.001)}$	= 3.819

TABLE A123

Air-to-Ground Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(One compared with two helicopters)

Helicopters used	Observation												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
	Advantages												
1	1	0	0	0	0	0	0	0	1	0	1	0	3
2	0	1	0	1	2	0	1	2	0	0	0	—	7

Observations – one helicopter n_1	= 12
Observations – two helicopters n_2	= 11
Sample variance – one helicopter s_1^2	= 0.188
Sample variance – two helicopters s_2^2	= 0.595
Pooled estimate of variance $\hat{\sigma}^2$	0.419
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.270
Student's t	= 1.430
Tabular $t_{(m = 21,\ \epsilon = 0.20)}$	= 1.323
Tabular $t_{(m = 21,\ \epsilon = 0.10)}$	= 1.721

TABLE A124

Air-to-Ground Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	1	1	0	0	2	0	1	0	1	6
Low	0	0	1	0	0	0	0	—	—	1

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 7
Sample variance – high tactic s_1^2	= 0.444
Sample variance – low tactic s_2^2	= 0.122
Pooled estimate of variance $\hat{\sigma}^2$	= 0.347
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.297
Student's t	= 1.765
Tabular $t_{(m = 14,\ \epsilon = 0.10)}$	= 1.761
Tabular $t_{(m = 14,\ \epsilon = 0.05)}$	= 2.145

TABLE A125

Air-to-Ground Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low, dismount and/or pop-up)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	1	1	0	0	2	0	1	0	1	6
Low, dismount and/or pop-up	0	1	2	0	0	0	0	—	—	3

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – high tactic s_1^2	= 0.444
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.551
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.374
Student's t	= 0.637
Tabular $t_{(m = 14,\ \epsilon = 0.50)}$	= 0.692
Tabular $t_{(m = 14,\ \epsilon = 0.60)}$	= 0.537

TABLE A126

Air-to-Ground Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Low	0	0	1	0	0	0	0	1
Low, dismount and/or pop-up	0	1	2	0	0	0	0	3

Observations – low tactic n_1	= 7
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – low tactic s_1^2	= 0.122
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.381
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.330
Student's t	= 0.866
Tabular $t_{(m = 12,\ \epsilon = 0.50)}$	= 0.695
Tabular $t_{(m = 12,\ \epsilon = 0.40)}$	= 0.873

TABLE A127

Air-to-Ground Interacquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	Advantages																
High, low	1	0	1	0	0	1	0	0	0	2	0	0	0	1	0	1	7
Low, dismount and/or pop-up	0	1	2	0	0	0	0	—	—	—	—	—	—	—	—	—	3

Observations – high, low tactics n_1	= 16
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – high, low tactics s_1^2	= 0.371
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.460
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.307
Student's t	= 0.959
Tabular $t_{(m = 21,\ \epsilon = 0.40)}$	= 0.859
Tabular $t_{(m = 21,\ \epsilon = 0.30)}$	= 1.063

TABLE A128

Overall Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(Ground compared with air)

Side	Run																							
	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	4-1	4-2	4-3	4-4	4-5	4-6	5-4	Total
	Advantages																							
Ground	5	6	12	8	9	13	6	4	5	11	5	4	9	8	12	7	2	0	3	2	9	7	4	151
Air	1	0	2	1	1	1	0	1	2	2	0	2	0	2	0	3	1	3	1	3	1	1	2	30
Difference x	4	6	10	7	8	12	6	3	3	9	5	2	9	6	12	4	1	-3	2	-1	8	6	2	121

Average difference $\bar{x}$ = 5.261

Sample variance s^2 = 14.454

Student's t = 6.490

Tabular $t_{(m = 22,\ \epsilon = 0.001)}$ = 3.792

TABLE A129

Overall Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(One compared with two helicopters)

Helicopters used	Observation												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
	Advantages												
1	5	9	6	4	5	5	9	12	2	3	7	4	71
2	6	12	8	13	11	4	8	7	0	2	9	—	80

Observations – one helicopter n_1	= 12
Observations – two helicopters n_2	= 11
Sample variance – one helicopter s_1^2	= 7.576
Sample variance – two helicopters s_2^2	= 15.108
Pooled estimate of variance $\hat{\sigma}^2$	= 12.238
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.460
Student's t	= 0.929
Tabular $t_{(m = 21,\ \epsilon = 0.40)}$	= 0.859
Tabular $t_{(m = 21,\ \epsilon = 0.30)}$	= 1.063

TABLE A130

Overall Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	5	12	9	4	11	12	2	9	7	71
Low	6	8	13	6	5	5	9	—	—	52

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 7
Sample variance – high tactic s_1^2	= 11.653
Sample variance – low tactic s_2^2	= 7.102
Pooled estimate of variance $\hat{\sigma}^2$	= 11.042
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.675
Student's t	= 0.275
Tabular $t_{(m = 14,\ \epsilon = 0.70)}$	= 0.393
Tabular $t_{(m = 14,\ \epsilon = 0.80)}$	= 0.258

TABLE A131

Overall Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low, dismount and/or pop-up tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	5	12	9	4	11	12	2	9	7	71
Low, dismount and or pop-up	4	8	7	0	3	2	4	—	—	28

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – high tactic s_1^2	= 11.653
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 6.571
Pooled estimate of variance $\hat{\sigma}^2$	= 10.777
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.654
Student's t	= 2.352
Tabular $t_{(m = 14,\ \epsilon = 0.05)}$	= 2.145
Tabular $t_{(m = 14,\ \epsilon = 0.02)}$	= 2.624

TABLE A132

Overall Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Low	6	8	13	6	5	5	9	52
Low, dismount and/or pop-up	4	8	7	0	3	2	4	28

Observations – low tactic n_1	= 7
Observations – low, dismount and or pop-up tactic n_2	= 7
Sample variance – low tactic s_1^2	= 7.102
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 6.571
Pooled estimate of variance $\hat{\sigma}^2$	= 7.976
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.509
Student's t	= 2.271
Tabular $t_{(m = 12,\ \epsilon = 0.05)}$	= 2.179
Tabular $t_{(m = 12,\ \epsilon = 0.02)}$	= 2.681

TABLE A133

Overall Ground-to-Air Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	Advantages																
High, low	5	6	12	8	9	13	6	4	5	11	5	9	12	2	9	7	123
Low, dismount and/or pop-up	4	8	7	0	3	2	4	—	—	—	—	—	—	—	—	—	28

Observations – high, low tactics n_1	= 16
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – high, low tactics s_1^2	= 9.715
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 6.571
Pooled estimate of variance $\hat{\sigma}^2$	= 9.592
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.404
Student's t	= 2.627
Tabular $t_{(m = 21,\ \epsilon = 0.02)}$	= 2.518
Tabular $t_{(m = 21,\ \epsilon = 0.01)}$	= 2.831

TABLE A134

Overall Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(One compared with two helicopters)

Helicopters used	Observation												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
	Advantages												
1	1	1	0	1	2	0	0	0	1	1	1	2	10
2	0	2	1	1	2	2	2	3	3	3	1	—	20

Observations – one helicopter n_1	= 12
Observations – two helicopters n_2	= 11
Sample variance – one helicopter s_1^2	= 0.472
Sample variance – two helicopters s_2^2	= 0.876
Pooled estimate of variance $\hat{\sigma}^2$	= 0.729
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.356
Student's t	= 2.764
Tabular $t_{(m = 21,\ \epsilon = 0.02)}$	= 2.518
Tabular $t_{(m = 21,\ \epsilon = 0.01)}$	= 2.831

TABLE A135

Overall Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	.8	9	Total
	Advantages									
High	1	2	1	1	2	0	1	1	1	10
Low	0	1	1	0	2	0	0	—	—	4

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 7
Sample variance – high tactic s_1^2	= 0.321
Sample variance – low tactic s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.472
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.346
Student's t	= 1.559
Tabular $t_{(m = 14,\ \epsilon = 0.26)}$	= 1.345
Tabular $t_{(m = 14,\ \epsilon = 0.10)}$	= 1.761

TABLE A136

Overall Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High compared with low, dismount and/or pop-up tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Advantages									
High	1	2	1	1	2	0	1	1	1	10
Low, dismount and/or pop-up	2	2	3	3	1	3	2	—	—	16

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up tactic n_2	= 7
Sample variance – high tactic s_1^2	= 0.321
Sample variance – low, dismount and or pop-up tactic s_2^2	= 0.490
Pooled estimate of variance $\hat{\sigma}^2$	= 0.451
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.339
Student's t	= 3.469
Tabular $t_{(m = 14,\ \epsilon = 0.01)}$	= 2.977
Tabular $t_{(m = 14,\ \epsilon = 0.001)}$	= 4.140

TABLE A137

Overall Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Low	0	1	1	0	2	0	0	4
Low, dismount and or pop-up	2	2	3	3	1	3	2	16

Observations – low tactic n_1	7
Observations – low, dismount and or pop-up tactic n_2	7
Sample variance – low tactic s_1^2	0.531
Sample variance – low, dismount and or pop-up tactic s_2^2	0.490
Pooled estimate of variance $\hat{\sigma}^2$	0.595
Best estimate of standard error of difference $\hat{\sigma}_w$	0.412
Student's t	4.157
Tabular $t_{(m = 12,\ \epsilon = 0.01)}$	3.055
Tabular $t_{(m = 12,\ \epsilon = 0.001)}$	4.318

TABLE A138

Overall Air-to-Ground Acquisition Advantages When Dispersed, Concentrated Ground Employment Was Utilized

(High, low compared with low, dismount and/or pop-up tactic)

Tactic	Observation																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	Advantages																
High, low	1	0	2	1	1	1	0	1	2	2	0	0	0	1	1	1	14
Low, dismount and/or pop-up	2	2	3	3	1	3	2	—	—	—	—	—	—	—	—	—	16

Observations – high, low tactics n_1	16
Observations – low, dismount and or pop-up tactic n_2	7
Sample variance – high, low tactics s_1^2	0.484
Sample variance – low, dismount and/or pop-up tactic s_2^2	0.490
Pooled estimate of variance $\hat{\sigma}^2$	0.532
Best estimate of standard error of difference $\hat{\sigma}_w$	0.331
Student's t	4.267
Tabular $t_{(m = 21,\ \epsilon = 0.001)}$	3.819

TABLE A139

One-Sided Ground-to-Air Acquisition Advantages When Low, Dismount and/or Pop-Up Tactic Was Utilized

(Moving compared with concentrated ground employment)

Employment	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Moving	0	2	0	—	—	—	—	2
Concentrated	3	8	5	0	3	2	4	25

Observations – moving elements n_1	= 3
Observations – concentrated elements n_2	7
Sample variance – moving elements s_1^2	= 0.889
Sample variance – concentrated elements s_2^2	5.388
Pooled estimate of variance $\hat{\sigma}^2$	= 5.048
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.550
Student's t	= 1.874
Tabular $t_{(m = 8,\ \epsilon = 0.10)}$	= 1.860
Tabular $t_{(m = 8,\ \epsilon = 0.05)}$	= 2.306

TABLE A140

Ground-to-Air Interacquisition Advantages When Low, Dismount and/or Pop-Up Tactic Was Utilized

(Moving compared with concentrated ground employment)

Employment	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Moving	0	0	0	—	—	—	—	0
Concentrated	1	0	2	0	0	0	0	3

Observations – moving elements n_1	= 3
Observations - concentrated elements n_2	= 7
Sample variance – moving elements s_1^2	= 0
Sample variance – concentrated elements s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.413
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.411
Student's t	= 0.966
Tabular $t_{(m = 8,\ \epsilon = 0.40)}$	= 0.889
Tabular $t_{(m = 8,\ \epsilon = 0.30)}$	= 1.108

TABLE A141

Overall Ground-to-Air Acquisition Advantages When Low, Dismount and/or Pop-Up Tactic Was Utilized

(Moving compared with concentrated ground employment)

Employment	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Moving	0	2	0	—	—	—	—	2
Concentrated	4	8	7	0	3	2	4	28

Observations – moving elements n_1	= 3
Observations – concentrated elements n_2	= 7
Sample variance – moving elements s_1^2	= 0.889
Sample variance – concentrated elements s_2^2	= 6.571
Pooled estimate of variance $\hat{\sigma}^2$	= 6.083
Best estimate of standard error of difference $\hat{\sigma}_w$	= 1.702
Student's t	= 1.959
Tabular $t_{(m = 8,\ \epsilon = 0.10)}$	= 1.860
Tabular $t_{(m = 8,\ \epsilon = 0.05)}$	= 2.306

TABLE A142

One-Sided Air-to-Ground Acquisition Advantages When Low, Dismount and/or Pop-Up Tactic Was Utilized

(Moving compared with concentrated ground employment)

Employment	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Moving	2	1	2	—	—	—	—	5
Concentrated	2	1	1	3	1	3	2	13

Observations – moving elements n_1	= 3
Observations – concentrated elements n_2	= 7
Sample variance – moving elements s_1^2	= 0.222
Sample variance – concentrated elements s_2^2	= 0.694
Pooled estimate of variance $\hat{\sigma}^2$	= 0.691
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.573
Student's t	= 0.332
Tabular $t_{(m = 8,\ \epsilon = 0.70)}$	= 0.399
Tabular $t_{(m = 8,\ \epsilon = 0.80)}$	= 0.262

TABLE A143

Air-to-Ground Interacquisition Advantages When Low, Dismount and/or Pop-Up Tactic Was Utilized

(Moving compared with concentrated ground employment)

Employment	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Moving	1	0	0	—	—	—	—	1
Concentrated	0	1	2	0	0	0	0	3

Observations – moving elements n_1	= 3
Observations – concentrated elements n_2	= 7
Sample variance – moving elements s_1^2	= 0.222
Sample variance – concentrated elements s_2^2	= 0.531
Pooled estimate of variance $\hat{\sigma}^2$	= 0.548
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.511
Student's t	= 0.186
Tabular $t_{(m = 8,\ \epsilon = 0.80)}$	= 0.262
Tabular $t_{(m = 8,\ \epsilon = 0.90)}$	= 0.130

TABLE A144

Overall Air-to-Ground Acquisition Advantages When Low, Dismount and/or Pop-Up Tactic Was Utilized

(Moving compared with concentrated ground employment)

Employment	Observation							
	1	2	3	4	5	6	7	Total
	Advantages							
Moving	3	1	2	—	—	—	—	6
Concentrated	2	2	3	3	1	3	2	16

Observations – moving elements n_1	= 3
Observations – concentrated elements n_2	= 7
Sample variance – moving elements s_1^2	= 0.667
Sample variance – concentrated elements s_2^2	= 0.490
Pooled estimate of variance $\hat{\sigma}^2$	= 0.679
Best estimate of standard error of difference $\hat{\sigma}_w$	= 0.568
Student's t	= 0.503
Tabular $t_{(m = 8,\ \epsilon = 0.60)}$	= 0.546
Tabular $t_{(m = 8,\ \epsilon = 0.70)}$	= 0.399

TABLE A145

Ground-to-Air Interacquisition Time Advantage, Seconds

Element	Run																												Advantages
	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	4-1	4-2	4-3	4-4	4-5	4-6	5-1	5-2	5-3	5-4	5-5	Total	
	Time advantage, sec																												
Tank	—	8	9	—	—	28	8	4	1	10	13	—	1	—	—	—	—	—	—	—	20	11	—	—	—	—	—	113	11
Jeep	—	—	—	—	14[a]	—	—	—	—	—	24	19	11[a]	—	19	—	—	—	—	—	—	1	—	—	—	—	—	88	6
Moving jeep	7	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	2
APC	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4,6	—	—	—	—	—	—	—	—	—	—	—	—	10	2
Moving APC	—	3	—	—	—	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19	—	—	—	—	31	3
Infantry	—	—	—	—	31[a]	—	23	—	4	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	74	4
Total	7	19	9	—	45	37	31	4	5	26	37	19	12	—	29	—	—	—	—	—	20	12	19	—	—	—	—	331	28
Mean advantage	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12
Median advantage	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10

[a]Reconstructed based on 5 sec assumed between sighting and time of fire.

TABLE A146

Air-to-Ground Interacquisition Time Advantage, Seconds

Element	Run																												Total	Advantages
	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	4-1	4-2	4-3	4-4	4-5	4-6	5-1	5-2	5-3	5-4	5-5			
	Time advantage, sec																													
Tank	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14	—	—	—	—	—	—	—	—	—	—	—	14	1
Jeep	—	—	—	—	—	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16	1
Moving jeep	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	4	1
APC	—	—	—	—	—	—	—	—	—	—	—	—	—	14	—	6	2	—	—	—	—	1	—	—	—	—	—	23	4
Moving APC	2	—	1	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	8	4
Infantry	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	1
Total	2	—	1	—	—	16	—	—	—	6	—	—	—	14	—	20	2	—	—	—	—	1	4	3	—	—	—	69	12
Mean advantage	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
Median advantage	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4

TABLE A147

Helicopter Mission Times, Minutes

(High compared with low tactic)

Tactic	Observation									
	1	2	3	4	5	6	7	8	9	Total
	Time, min									
High	9	13	11	11	6	14	15	7	6	92
Low	24	13	30	11	10	33	21	32	—	174

Observations – high tactic n_1	= 9
Observations – low tactic n_2	= 8
Sample variance – high tactic s_1^2	= 11.167
Sample variance – low tactic s_2^2	= 79.438
Pooled estimate of variance $\hat{\sigma}^2$	= 49.067
Best estimate of standard error of difference $\hat{\sigma}_w$	= 3.404
Student's t	= 3.355
Tabular $t_{(m = 15,\ \epsilon = 0.01)}$	= 2.947
Tabular $t_{(m = 15,\ \epsilon = 0.001)}$	= 4.073

TABLE A148

Helicopter Mission Times, Minutes

(High compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Time, min										
High	9	13	11	11	6	14	15	7	6	—	92
Low, dismount and/or pop-up	8	10	54	42	15	19	68	38	62	42	358

Observations – high tactic n_1	= 9
Observations – low, dismount and/or pop-up tactic n_2	= 10
Sample variance – high tactic s_1^2	= 11.167
Sample variance – low, dismount and/or pop-up tactic s_2^2	= 428.960
Pooled estimate of variance $\hat{\sigma}^2$	= 258.241
Best estimate of standard error of difference $\hat{\sigma}_w$	= 7.388
Student's t	= 3.447
Tabular $t_{(m = 17,\ \epsilon = 0.01)}$	= 2.898
Tabular $t_{(m = 17,\ \epsilon = 0.001)}$	= 3.965

TABLE A149

Helicopter Mission Time, Minutes

(Low compared with low, dismount and/or pop-up tactic)

Tactic	Observation										
	1	2	3	4	5	6	7	8	9	10	Total
	Time, min										
Low	24	13	30	11	10	33	21	32	—	—	174
Low, dismount and/or pop-up	8	10	54	42	15	19	68	38	62	42	358

Observations – low tactic	n_1	= 8
Observations – low, dismount and/or pop-up tactic	n_2	= 10
Sample variance – low tactic	s_1^2	= 79.438
Sample variance – low, dismount and/or pop-up tactic	s_2^2	= 428.960
Pooled estimate of variance	$\hat{\sigma}^2$	= 307.819
Best estimate of standard error of difference	$\hat{\sigma}_w$	= 8.322
Student's t		= 1.688
Tabular $t_{(m = 16,\ \epsilon = 0.20)}$		= 1.337
Tabular $t_{(m = 16,\ \epsilon = 0.10)}$		= 1.746

Appendix B

ANALYSIS OF FILM DATA

Tables

STATISTICAL TECHNIQUES EMPLOYED

Statistical tests were used to test the null hypothesis that the means of the samples examined came from the same population, and acceptance or rejection of the hypothesis was based on a 5 percent level of significance. In cases where only two means were compared, the standard Student's test[7] was used assuming that the variances are not necessarily equal. When comparisons of more than two means were required, a technique developed by Clyde Kramer[8] to test means with unequal numbers of replications was employed.

Comparison of Two Normal Populations[7]

Assume $\sigma_1^2 \neq \sigma_2^2$. When this situation prevails, i.e., when one is unwilling to assume that the variances are equal, a reasonably good approximate procedure such as is indicated below is followed. Compute

$$t' = (\bar{X}_1 - \bar{X}_2)/\sqrt{(s_1^2/N_1 + s_2^2/N_2)}$$

and reject

$$H_0 : \bar{X}_1 = \bar{X}_2$$

if

$$t' > (w_1 t_1 + w_2 t_2)/(w_1 + w_2) = \text{Tabular } t$$

where $w_1 = s_1^2/N_1$

$w_2 = s_2^2/N_2$

$t_1 = t_{(1 - \alpha/2)(N_1 - 1)}$

$t_2 = t_{(1 - \alpha/2)(N_2 - 1)}$

Extension of Multiple-Range Tests to Group Means with Unequal Numbers of Replications

In many fields of research one is faced with the task of comparing the effects of treatments that have been replicated unequally. Several writers have developed multiple-range tests to show differences among treatments that have been replicated the same number of times when nothing was specified concerning the treatments. The following Kramer method is an extension of Duncan's Multiple-Range and Multiple F Tests published in Biometrics, November 1955.[8]

In Duncan's test the difference between any two ranked means is significant if the difference exceeds a shortest significant range. This shortest significant range R_p is obtained by multiplying the standard error of a mean $S_{\bar{X}}$ by a given value z_{p,n_2} tabulated by Duncan for the 5-percent and 1-percent tests of significant studentized ranges. In Duncan's terminology, n_2 is the degree of freedom of the error mean square and $p = 1, 2, \ldots, t$, where t is the number of means concerned.

If $\bar{X}_1, \bar{X}_2, \ldots, \bar{X}_l$ are based on $N_1, N_2, \ldots, N_l$ replications, then $S^2_{\bar{X}_i} = S^2/N_i$.

Now for $\bar{X}_i - \bar{X}_j$ to be significant, $\bar{X}_i - \bar{X}_j$ should exceed

$$\sqrt{1/2\,(1/N_i + 1/N_j)\,s^2} \times z_{p_1 N_2}$$

So

$$(\bar{X}_i - \bar{X}_j) > \sqrt{1/2\,(1/N_i + 1/N_j)\,s^2} \times z_{p_1 N_2}$$

and

$$(\bar{X}_i - \bar{X}_j)\,\sqrt{2N_i N_j / N_i + N_j} > s z_{p_1 N_2}$$

indicating that for group means based on unequal numbers a table of factors $R'_p = s z_{p,N_2}$, where s^2 is the mean square for error, should be set up in actually making this test in each individual case.

This extension to unequal numbers of replications will be a conservative test. Evaluation of specified significance and prediction levels would be extremely difficult and impracticable. If the number of replications differs greatly, there will be an increased probability of a significant difference within a subset of rank means classified as homogeneous by this test.

One Compared with Two Helicopters

TABLE B1

Mean Survival Probabilities for One Compared with Two Helicopters When Conditional Kill Probability Is 0.2

Consideration	Helicopters	
	1	2
Runs N	14	13
Variance s^2	0.126	0.153
Weight factor w	0.00900	0.01180
Mean survivability $\bar{X}$	0.402	0.483

Calculated t' = 0.563
Tabular t = 2.171
∴ not significant at 5% level

TABLE B2

Mean Survival Probabilities for One Compared with Two Helicopters When Conditional Kill Probability Is 0.4

Consideration	Helicopters	
	1	2
Runs N	14	13
Variance s^2	0.127	0.180
Weight factor w	0.00907	0.01380
Mean survivability $\bar{X}$	0.286	0.384

Calculated t' = 0.649
Tabular t = 2.171
∴ not significant at 5% level

TABLE B3

Mean Survival Probabilities for One Compared with Two Helicopters When Conditional Kill Probability Is 0.6

Consideration	Helicopters	
	1	2
Runs N	14	13
Variance s^2	0.124	0.195
Weight factor w	0.00886	0.01500
Mean survivability $\bar{X}$	0.235	0.343

Calculated t' = 0.701
Tabular t = 2.172
∴ not significant at 5% level

TABLE B4

Mean Survival Probabilities for One Compared with Two Helicopters When Conditional Kill Probability Is 0.8

Consideration	Helicopters	
	1	2
Runs N	14	13
Variance s^2	0.121	0.203
Weight factor w	0.00864	0.01560
Mean survivability $\bar{X}$	0.207	0.325

Calculated t' = 0.756
Tabular t = 2.172
∴ not significant at 5% level

TABLE B5

Mean Survival Probabilities for One Compared with Two Helicopters When Conditional Kill Probability Is 1.0

Consideration	Helicopters	
	1	2
Runs N	14	13
Variance s^2	0.119	0.209
Weight factor w	0.00850	0.01610
Mean survivability $\bar{X}$	0.189	0.315

Calculated t' = 0.803
Tabular t = 2.172
∴ not significant at 5% level

Variations in Tactics

TABLE B6

Mean Survival Probabilities for Various Tactics When Conditional Kill Probability Is 0.2

Consideration	Tactic		
	High	Low	Low, dismount and/or pop-up
Runs N	12	12	16
Mean survivability $\bar{X}$	0.472	0.473	0.713

F = 2.07
Tabular F = 3.30
∴ not significant at 5% level

TABLE B7

Mean Survival Probabilities for Various Tactics When Conditional Kill Probability Is 0.4

Consideration	Tactic		
	High	Low	Low, dismount and/or pop-up
Runs N	12	12	16
Mean survivability $\bar{X}$	0.285	0.347	0.675

F = 4.53
Tabular F = 3.30
∴ significant at 5% level

Significant Studentized Ranges

p	2	3
$z_{p,37}$	2.87	3.02
R'_p	1.07	1.13

s = 0.373

High compared with low, dismount and/or pop-up

$$(\bar{X}_{LDP} - \bar{X}_H)\sqrt{2 \times 16 \times 12/16 + 12} = 1.44 > 1.13$$

∴ significant at 5% level

Low compared with low, dismount and/or pop-up

$$(\bar{X}_{LDP} - \bar{X}_L)\sqrt{2 \times 16 \times 12/16 + 12} = 1.21 > 1.07$$

∴ significant at 5% level

High compared with low

$$(\bar{X}_L - \bar{X}_H)\sqrt{2 \times 12 \times 12/12 + 12} = 0.22 < 1.07$$

∴ not significant at 5% level

TABLE B8

Mean Survival Probabilities for Various Tactics When Conditional Kill Probability Is 0.6

Consideration	Tactic		
	High	Low	Low, dismount and/or pop-up
Runs N	12	12	16
Mean survivability $\bar{X}$	0.193	0.286	0.648

$F = 5.97$
Tabular $F = 3.30$
$\therefore$ significant at 5% level

Significant Studentized Ranges

p	2	3
$z_{p,37}$	2.87	3.02
R'_p	1.07	1.13

$s = 0.373$

High compared with low, dismount and/or pop-up

$$(\bar{X}_{LDP} - \bar{X}_H)\sqrt{2 \times 16 \times 12/16 + 12} = 1.68 > 1.13$$

$\therefore$ significant at 5% level

Low compared with low, dismount and/or pop-up

$$(\bar{X}_{LDP} - \bar{X}_L)\sqrt{2 \times 16 \times 12/16 + 12} = 1.34 > 1.07$$

$\therefore$ significant at 5% level

High compared with low

$$(\bar{X}_L - \bar{X}_H)\sqrt{2 \times 12 \times 12/12 + 12} = 0.32 < 1.07$$

$\therefore$ *not* significant at 5% level

TABLE B9

Mean Survival Probabilities for Various Tactics When Conditional Kill Probability Is 0.8

Consideration	Tactic		
	High	Low	Low, dismount and/or pop-up
Runs N	12	12	16
Mean survivability $\bar{X}$	0.141	0.249	0.628

$F = 6.69$

$F_{.05} = 3.30$

$\therefore$ significant at 5% level

Significant Studentized Ranges

p	2	3
$z_{p,37}$	2.87	3.02
R'_p	1.07	1.13

$s = 0.374$

High compared with low, dismount and/or pop-up

$$(\bar{X}_{LDP} - \bar{X}_H)\sqrt{2 \times 16 \times 12/16 + 12} = 1.80 > 1.13$$

$\therefore$ significant at 5% level

Low compared with low, dismount and/or pop-up

$$(\bar{X}_{LDP} - \bar{X}_L)\sqrt{2 \times 16 \times 12/16 + 12} = 1.40 > 1.07$$

$\therefore$ significant at 5% level

High compared with low

$$(\bar{X}_L - \bar{X}_H)\sqrt{2 \times 12 \times 12/12 + 12} = 0.374 < 1.07$$

$\therefore$ not significant at 5% level

TABLE B10

Mean Survival Probabilities for Various Tactics When Conditional Kill Probability Is 1.0

Consideration	Tactic		
	High	Low	Low, dismount and/or pop-up
Runs N	12	12	16
Mean survivability $\bar{X}$	0.109	0.225	0.612

F = 6.99
Tabular F = 3.30
∴ significant at 5% level

Significant Studentized Ranges

p	2	3
$z_{p,.37}$	2.87	3.02
R'_p	1.08	1.14

s = 0.377

High compared with low, dismount and/or pop-up

$$(\bar{X}_{LDP} - \bar{X}_H)\sqrt{2 \times 16 \times 12/16 + 12} = 1.86 > 1.14$$

∴ significant at 5% level

Low compared with low, dismount and/or pop-up

$$(\bar{X}_{LDP} - \bar{X}_L)\sqrt{2 \times 16 \times 12/16 + 12} = 1.43 > 1.08$$

∴ significant at 5% level

High compared with low

$$(\bar{X}_L - \bar{X}_H)\sqrt{2 \times 12 \times 12/12 + 12} = 0.40 < 1.08$$

∴ not significant at 5% level

Variations in Tactics and Helicopters Used

TABLE B11

Mean Survival Probabilities for Various Tactics and Helicopters Used When Conditional Kill Probability Is 0.2

Consideration	Tactic					
	High		Low		Low, dismount and/or pop-up	
	Helicopters					
	1	2	1	2	1	2
Runs N	6	3	4	4	4	6
Mean survivability $\bar{X}$	0.361	0.323	0.160	0.430	0.706	0.598

$F = 1.16$
$F_{.05} = 2.75$
$\therefore$ not significant at 5% level

TABLE B12

Mean Survival Probabilities for Various Tactics and Helicopters Used When Conditional Kill Probability Is 1.0

Consideration	Tactic					
	High		Low		Low, dismount and/or pop-up	
	Helicopters					
	1	2	1	2	1	2
Runs N	6	3	4	4	4	6
Mean survivability $\bar{X}$	0.055	0.006	0.003	0.256	0.575	0.510

$F = 2.07$
$F_{.05} = 2.75$
$\therefore$ not significant at 5% level

Variations in Employment

TABLE B13

Mean Survival Probabilities for Various Employments When Conditional Kill Probability Is 0.2

Consideration	Employment		
	Dispersed	Concentrated	Moving
Runs N	15	19	6
Mean survivability $\bar{X}$	0.411	0.557	1.000

$F = 6.85$
$F_{.05} = 3.30$
$\therefore$ significant at 5% level

Significant Studentized Ranges

p	2	3
$z_{p,37}$	2.87	3.02
R'_p	0.95	1.00

$s = 0.33$

Dispersed compared with moving

$$(\bar{X}_M - \bar{X}_D)\sqrt{2 \times 15 \times 6/21} = 1.73 > 1.00$$

$\therefore$ significant at 5% level

Dispersed compared with concentrated

$$(\bar{X}_C - \bar{X}_D)\sqrt{2 \times 15 \times 19/34} = 0.599 < 0.95$$

$\therefore$ *not* significant at 5% level

Moving compared with concentrated

$$(\bar{X}_C - \bar{X}_M)\sqrt{2 \times 19 \times 6/25} = 1.34 > 0.95.$$

$\therefore$ significant at 5% level

TABLE B14

Mean Survival Probabilities for Various Employments When Conditional Kill Probability Is 0.4

Consideration	Employment		
	Dispersed	Concentrated	Moving
Runs N	15	19	6
Mean survivability $\bar{X}$	0.252	0.452	1.00

$F = 11.00$

$F_{.05} = 3.30$

$\therefore$ significant at 5% level

Significant Studentized Ranges

n	2	3
$z_{p,.37}$	2.87	3.02
R'_p	0.947	0.997

$s = 0.330$

Moving compared with dispersed

$$(\bar{X}_D - \bar{X}_M)\sqrt{2 \times 15 \times 6/21} = 2.19 > 0.997$$

$\therefore$ significant at 5% level

Moving compared with concentrated

$$(\bar{X}_C - \bar{X}_M)\sqrt{2 \times 19 \times 6/25} = 1.65 > 0.947$$

$\therefore$ significant at 5% level

Dispersed compared with concentrated

$$(\bar{X}_C - \bar{X}_D)\sqrt{2 \times 19 \times 15/34} = 0.820 < 0.947$$

$\therefore$ *not* significant at 5% level

TABLE B15

Mean Survival Probabilities for Various Employments When Conditional Kill Probability Is 0.6

Consideration	Employment		
	Dispersed	Concentrated	Moving
Runs N	15	19	6
Mean survivability $\bar{X}$	0.173	0.396	1.000

$F = 13.76$

$F_{.05} = 3.30$

$\therefore$ significant at 5% level

Significant Studentized Ranges

p	2	3
$z_{p,37}$	2.87	3.02
R'_p	0.93	0.98

$s = 0.325$

Moving compared with dispersed

$$(\bar{X}_D - \bar{X}_M)\sqrt{2 \times 15 \times 6/21} = 2.42 > 0.98$$

$\therefore$ significant at 5% level

Moving compared with concentrated

$$(\bar{X}_C - \bar{X}_M)\sqrt{2 \times 19 \times 6/25} = 1.82 > 0.93$$

$\therefore$ significant at 5% level

Dispersed compared with concentrated

$$(\bar{X}_C - \bar{X}_D)\sqrt{2 \times 19 \times 15/34} = 0.91 < 0.93$$

$\therefore$ **not** significant at 5% level

TABLE B16

Mean Survival Probabilities for Various Employments When Conditional Kill Probability Is 0.8

Consideration	Employment		
	Dispersed	Concentrated	Moving
Runs N	15	19	6
Mean survivability $\bar{X}$	0.128	0.358	1.000

$F = 15.93$

$F_{.05} = 3.30$

$\therefore$ significant at 5% level

Significant Studentized Ranges

p	2	3
$z_{p,37}$	2.87	3.02
R'_p	0.92	0.97

$s = 0.321$

Moving compared with dispersed

$$(\bar{X}_D - \bar{X}_M)\sqrt{2 \times 15 \times 6.21} = 2.55 > 0.97$$

$\therefore$ significant at 5% level

Moving compared with concentrated

$$(\bar{X}_C - \bar{X}_M)\sqrt{2 \times 19 \times 6.25} = 1.94 > 0.92$$

$\therefore$ significant at 5% level

Dispersed compared with concentrated

$$(\bar{X}_C - \bar{X}_D)\sqrt{2 \times 19 \times 15.34} = 0.94 > 0.92$$

$\therefore$ significant at 5% level

TABLE B17

Mean Survival Probabilities for Various Employments When Conditional Kill Probability is 1.0

Consideration	Employment		
	Dispersed	Concentrated	Moving
Runs N	15	19	6
Mean survivability $\bar{X}$	0.099	0.333	1.000

$F = 17.18$

$F_{.05} = 3.30$

$\therefore$ significant at 5% level

Significant Studentized Ranges

p	2	3
$z_{p,37}$	2.87	3.02
R'_p	0.92	0.96

$s = 0.319$

Moving compared with dispersed

$$(\bar{X}_D - \bar{X}_M)\sqrt{2 \times 15 \times 6/21} = 2.64 > 0.96$$

$\therefore$ significant at 5% level

Moving compared with concentrated

$$(\bar{X}_C - \bar{X}_M)\sqrt{2 \times 19 \times 6/25} = 2.01 > 0.92$$

$\therefore$ significant at 5% level

Dispersed compared with concentrated

$$(\bar{X}_C - \bar{X}_D)\sqrt{2 \times 19 \times 15/34} = 0.96 > 0.92$$

$\therefore$ significant at 5% level

One Compared with Two Helicopters

TABLE B18

Mean Weighted Fraction Acquired for One Compared with Two Helicopters When Conditional Kill Probability Is 0.02

Consideration	Helicopters	
	1	2
Runs N	14	13
Variance s^2	0.4669	0.4137
Weight factor w	0.334	0.318
Mean survivability $\bar{X}$	0.299	0.420

Calculated t' = 1.49
Tabular t = 2.169
∴ not significant at 5% level

TABLE B19

Mean Weighted Fraction Acquired for One Compared with Two Helicopters When Conditional Kill Probability Is 1.0

Consideration	Helicopters	
	1	2
Runs N	14	13
Variance s^2	0.6200	0.4258
Weight factor w	0.443	0.328
Mean survivability $\bar{X}$	0.248	0.353

Calculated t' = 1.25
Tabular t = 2.17
∴ not significant at 5% level

Variations in Tactics

TABLE B20

Mean Weighted Fraction Acquired for Various Tactics When Conditional Kill Probability Is 0.2

Consideration	Tactic		
	High	Low	Low, dismount and/or pop-up
Runs N	9	8	10
Mean survivability $\bar{X}$	0.347	0.337	0.382

F = 0.102
$F_{.05}$ = 3.40
∴ not significant at 5% level

TABLE B21

Mean Weighted Fraction Acquired for Various Tactics When Conditional Kill Probability Is 1.0

Consideration	Tactic		
	High	Low	Low, dismount and/or pop-up
Runs N	9	8	10
Mean survivability $\bar{X}$	0.275	0.260	0.351

$F = 0.36$

$F_{.05} = 3.40$

$\therefore$ not significant at 5% level

Variations in Tactics and Helicopters Used

TABLE B22

Mean Weighted Fraction Acquired for Various Tactics and Helicopters Used When Conditional Kill Probability Is 0.2

Consideration	Tactic					
	High		Low		Low, dismount and/or pop-up	
	Helicopters					
	1	2	1	2	1	2
Runs N	6	3	4	4	4	6
Mean survivability $\bar{X}$	0.319	0.404	0.275	0.395	0.293	0.442

$F = 0.39$

$F_{.05} = 2.70$

$\therefore$ not significant at 5% level

TABLE B23

Mean Weighted Fraction Acquired for Various Tactics and Helicopters Used When Conditional Kill Probability Is 1.0

Consideration	Tactic					
	High		Low		Low, dismount and/or pop-up	
	Helicopters					
	1	2	1	2	1	2
Runs N	6	3	4	4	4	6
Mean survivability $\bar{X}$	0.265	0.293	0.205	0.316	0.265	0.408

$F = 0.36$

$F_{.05} = 2.70$

$\therefore$ not significant at 5% level

TABLE B24

Mean Weighted Fraction Acquired for Various Employments When Conditional Kill Probability Is 0.2

Consideration	Employment		
	Dispersed	Concentrated	Moving
Runs N	10	13	4
Mean survivability $\bar{X}$	0.371	0.310	0.475

$F = 0.86$
$F_{.05} = 3.40$
$\therefore$ not significant at 5% level

TABLE B25

Mean Weighted Fraction Acquired for Various Employments When Conditional Kill Probability Is 1.0

Consideration	Employment		
	Dispersed	Concentrated	Moving
Runs N	10	13	4
Mean survivability $\bar{X}$	0.283	0.256	0.475

$F = 1.34$
$F_{.05} = 3.40$
$\therefore$ not significant at 5% level

Appendix C

MISSION PATHS

Figures

Data were collected from four independent sources: pen recorder in response to radio reports, maps drawn by RAC analysts at the ground positions, flight paths drawn by pilots at air control after completion of the mission (including the position of the targets acquired and the point of flight at which the acquisition occurred), and gun-camera film. The overlapping of the information collected allowed measuring the reliability of the data and made possible the reconstruction of the events in the experimental runs in four dimensions for position and time of happening. These reconstructions are shown in accompanying Figs. C2–C28.

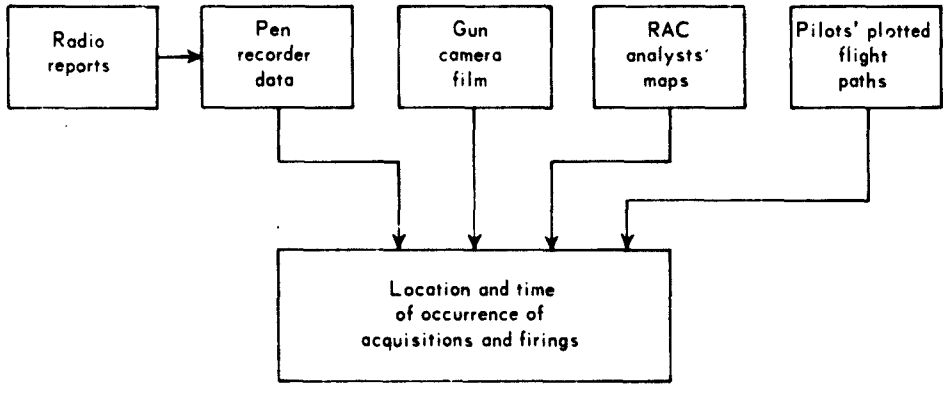


Fig. C1—Schematic of Event Reconstruction

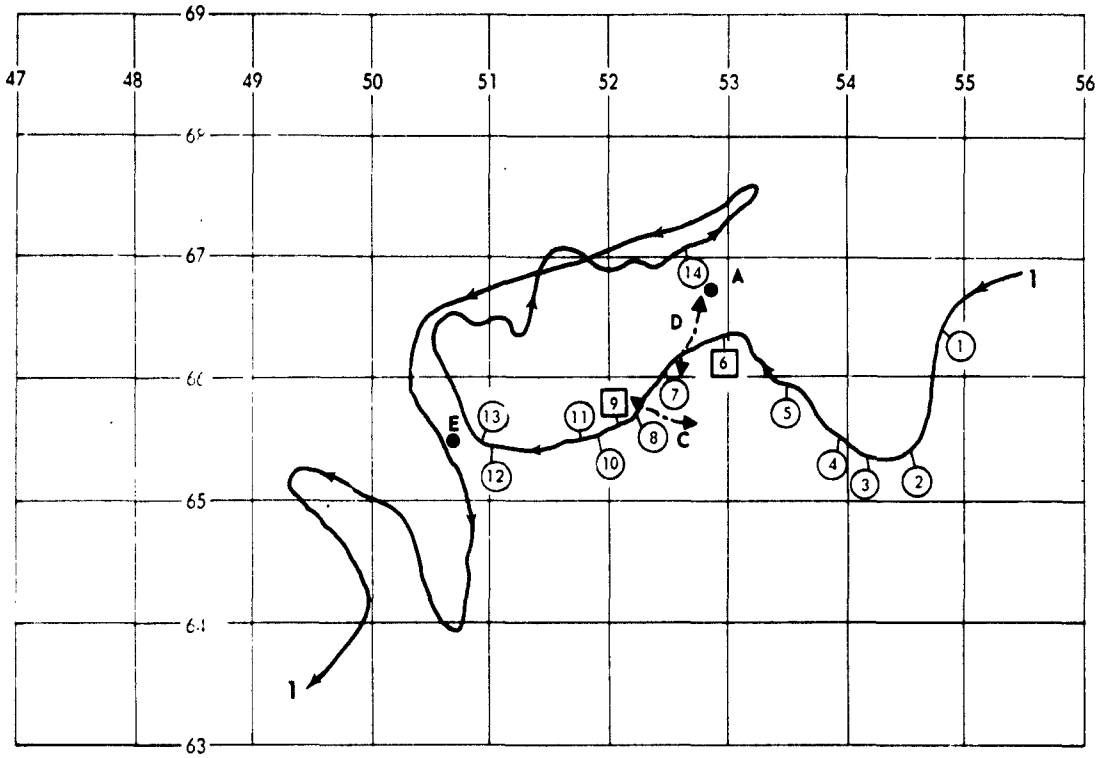


Fig C2—Reconstruction of Events in Run 1-1

1, OH-13, A, Tank, C, Moving APC, D, Moving jeep; E, Infantry machinegun position; ◯, Ground; □, Air, Mission path: ——, helicopter 1; -•-•-, C, D

Symbol	Event	Elapsed time, min : sec
①	A Acquires 1	2:04
②	A Acquires 1	3:52
③	D Acquires 1	3:55
④	A Fires at 1 (including simulator fire)	3:56
⑤	D Fires at 1	4:00
⑥	1 Acquires D	4:02
⑦	D Acquires 1	4:40
⑧	D Fires at 1	4:42
⑨	1 Acquires C	4:43
⑩	C Acquires 1	4:45
⑪	C Fires at 1	4:48
⑫	E Acquires 1	4:54
⑬	E Fires at 1 (including firing blanks)	4:56
⑭	A Acquires 1	6:22
	End of mission	9:00

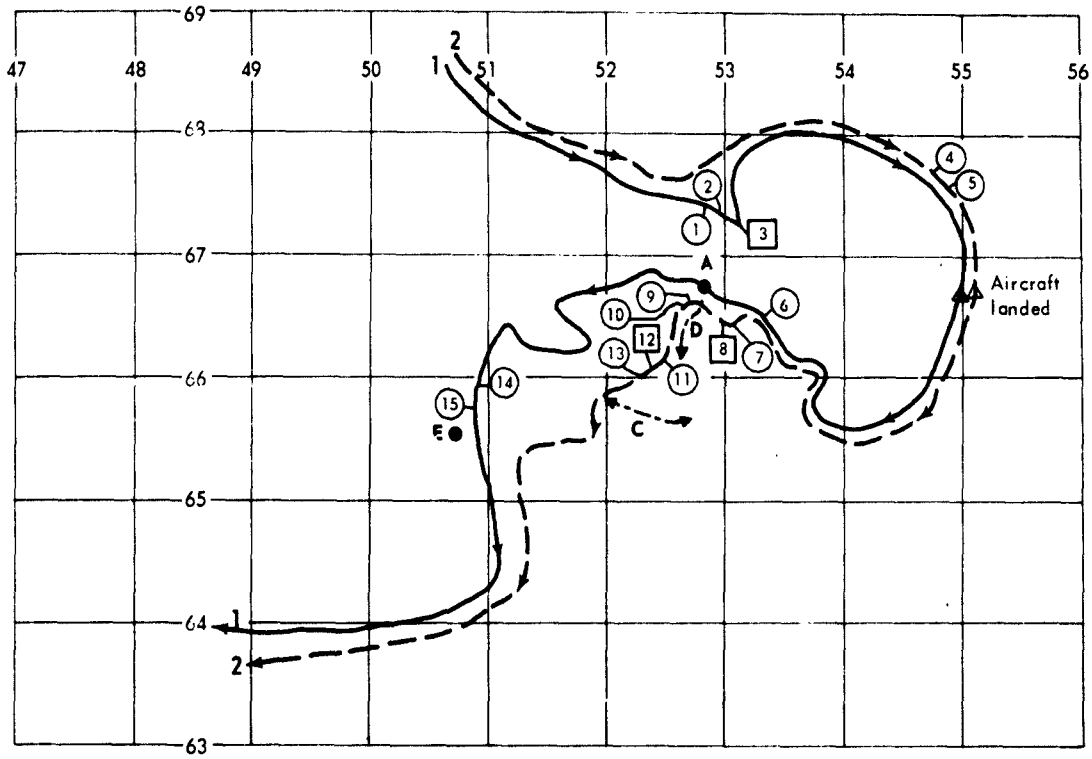


Fig. C3—Reconstruction of Events in Run 1-2

1 and 2, OH-13; A, Tank; C, Moving APC; D, Moving jeep; E, Infantry machinegun position; ◯, Ground; □, Air; Mission path: ——, helicopter 1; — —, helicopter 2; •—•—, C, D

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min : sec
①	A Acquires 1	0:19	⑨	D Acquires 2	27:07
②	A Fires at 1 (including simulator fire)	0:21	⑩	D Fires at 2	27:08
			⑪	C Acquires 2	28:25
[3]	1 Acquires A	0:27	[12]	2 Acquires C	28:28
④	A Acquires 1, 2	4:04	⑬	C Fires at 2	28:31
⑤	A Fires at 2 (including simulator fire)	4:06	⑭	E Acquires 1	31:45
			⑮	E Fires at 1 (including firing blanks)	31:47
⑥	D Acquires 1, 2	24:58			
⑦	D Fires at 2	25:32		End of mission	33:00
[8]	2 Acquires D	25:35			

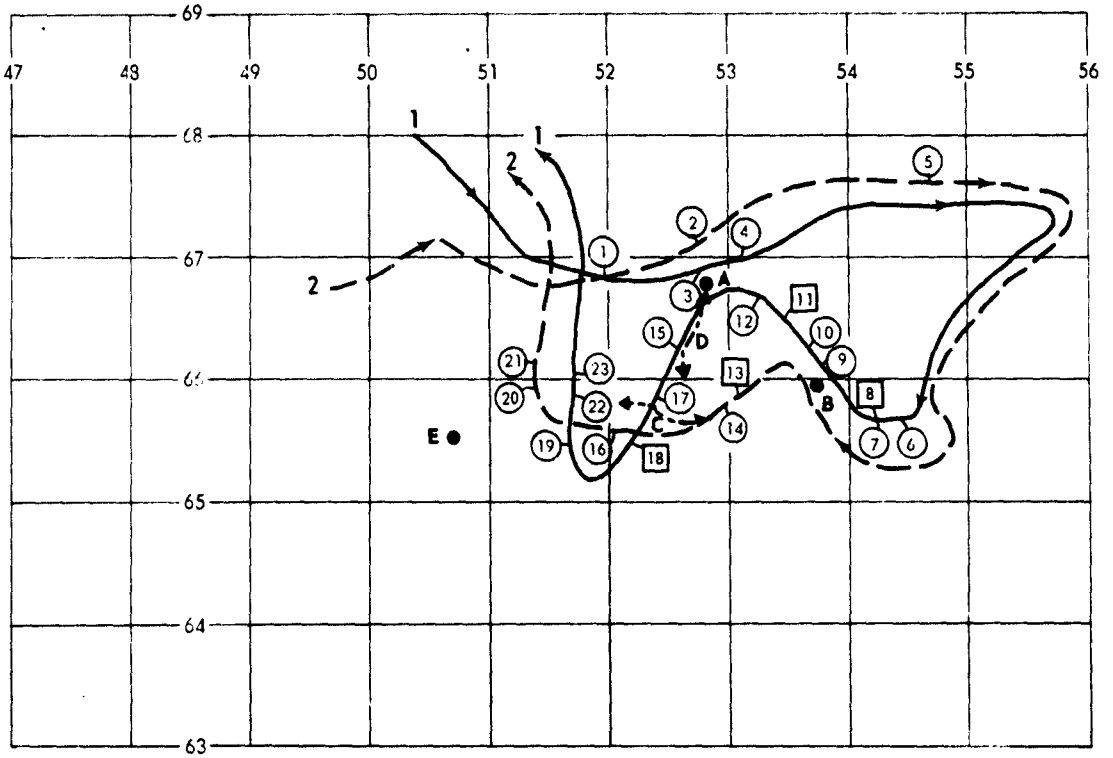


Fig. C4—Reconstruction of Events in Run 1-3

1 and 2, OH-13; A, Tank; B, Jeep; C, Moving APC; D, Moving jeep; E, Infantry machinegun position; ◯ Ground, □, Air, Mission path: ——, helicopter 1; — — , helicopter 2; -·-·-, C, D

Symbol	Event	Elapsed time, min . sec
①	D Acquires 1	2:42
②	B Acquires 2	4:52
③	B Acquires 1	5:10
④	A Acquires 1	5.15
⑤	B Acquires 1, 2	5 36
⑥	A Acquires 1	8:20
⑦	A Fires at 1	8:22
⑧	1 Acquires B	9:38
⑨	A Acquires 1	10:05
⑩	A Fires at 1 (including simulator fire)	10:07
⑪	1 Acquires A	10·14
⑫	A Fires at 1	10.18
⑬	2 Acquires C	10:47
⑭	C Acquires 2	10:48
⑮	E Acquires 1	10.51
⑯	C Fires at 2	10:52
⑰	C Acquires 1	10:54
⑱	1 Acquires C	11:06
⑲	C Fires at 1	11:18
⑳	E Acquires 2	11:51
㉑	E Fires at 2 (including firing blanks)	12.37
㉒	D Acquires 1	13:36
㉓	D Fires at 1	13 37
	End of mission	15:00

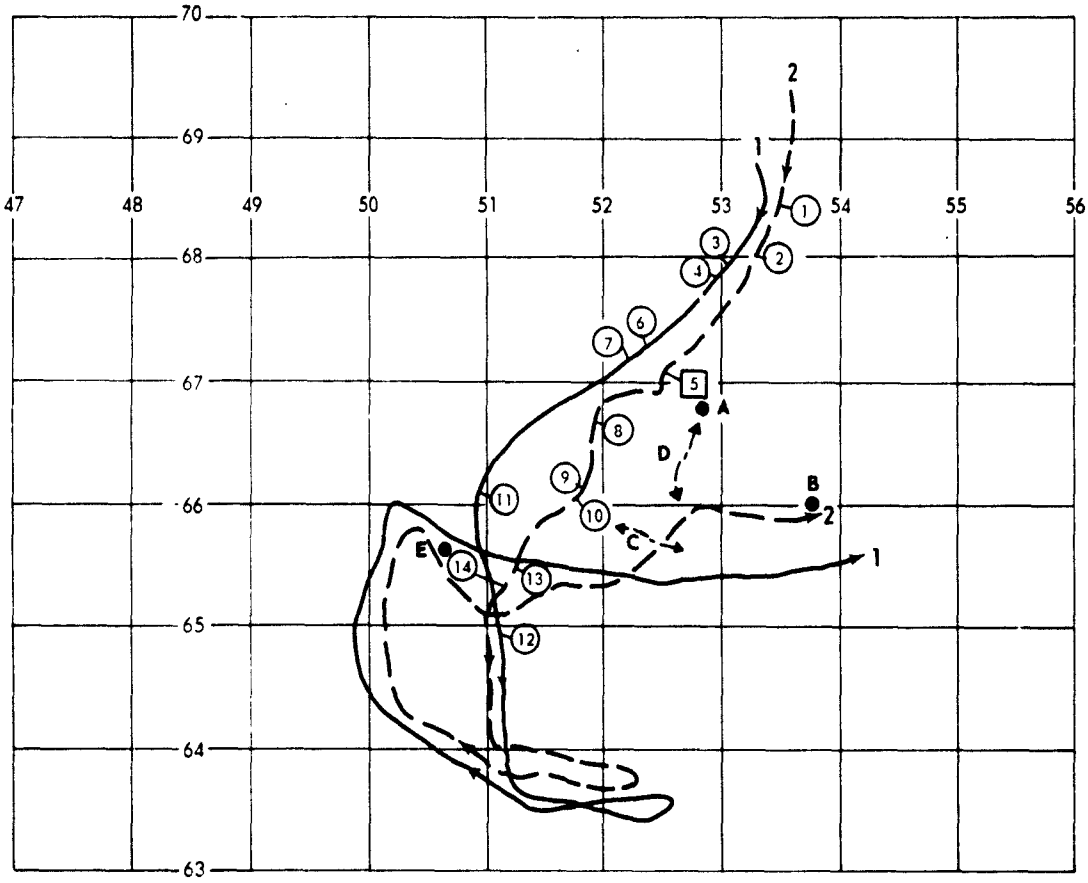


Fig C5—Reconstruction of Events in Run 1-4

1 and 2, OH-13; A, Tank, B, Jeep; C, Moving APC; D, Moving jeep; E, Infantry machinegun position; ◯, Ground; □, Air, Mission path. ——, helicopter 1; — —, helicopter 2; •—•—, C, D

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min : sec
①	A Acquires 2	12:23	⑧	C Acquires 2	16:07
②	A Fires at 2 (including simulator fire)	12:25	⑨	D Acquires 2	16:24
③	A Acquires 1	14:53	⑩	D Fires at 2	16:26
④	A Fires at 1 (including simulator fire)	14:54	⑪	E Acquires 1	17:18
⑤	2 Acquires A	15:24	⑫	E Fires at 1	18.18
⑥	D Acquires 1	16 03	⑬	E Acquires 2	19:38
⑦	D Fires at 1	16.05	⑭	E Fires at 2	19:40
				End of mission	21:00

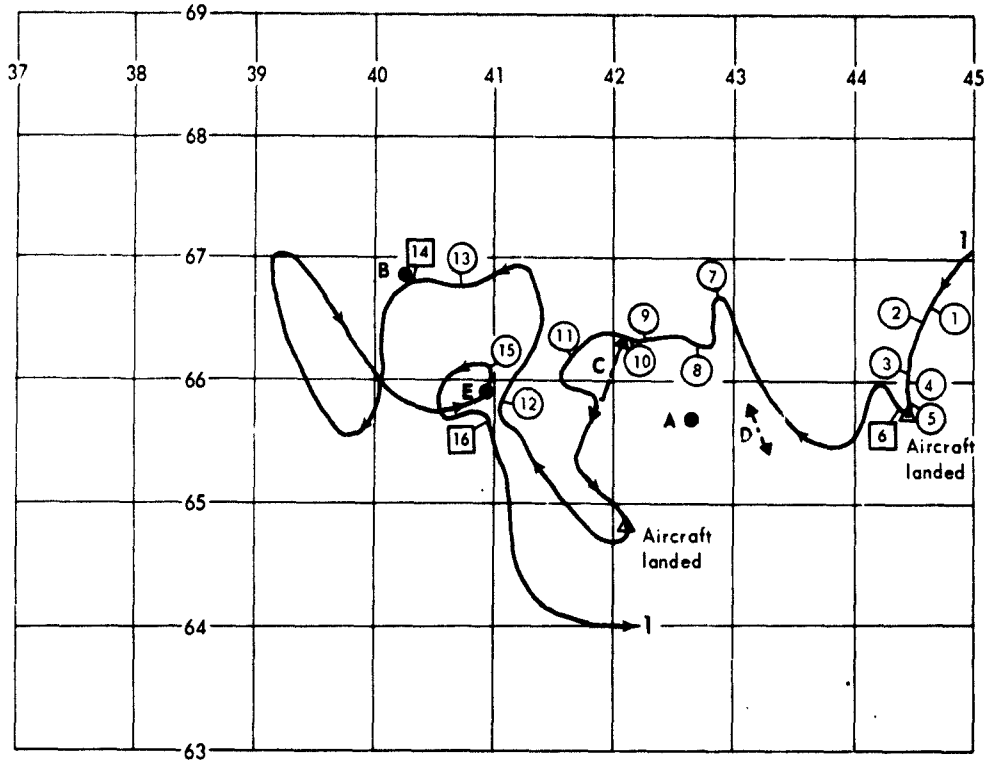


Fig. C6—Reconstruction of Events in Run 2-1

1, OH-13; A, Tank; B, Jeep; C, Moving APC; D, Moving jeep; E, Infantry machinegun position; ◯, Ground; □, Air; Mission path: ——, helicopter 1, -·-·-, C, D

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min : sec
①	A Acquires 1	3:09	⑩	E Acquires 1	5:07
②	A Fires at 1 (including simulator fire)	3:12	⑪	E Fires at 1 (including firing blanks)	5:15
③	D Acquires 1	3:24	⑫	E Fires at 1	5:44
④	D Fires at 1	3:26	⑬	B Fires at 1	6:12
⑤	E Acquires 1	3:29	⑭	1 Acquires B	6:21
⑥	1 Acquires A	4:00	⑮	E Fires at 1 (including firing blanks)	12:42
⑦	B Acquires 1	4:52	⑯	1 Acquires E	13:08
⑧	C Acquires 1	5:00		End of mission	13:30
⑨	C Fires at 1	5:07			

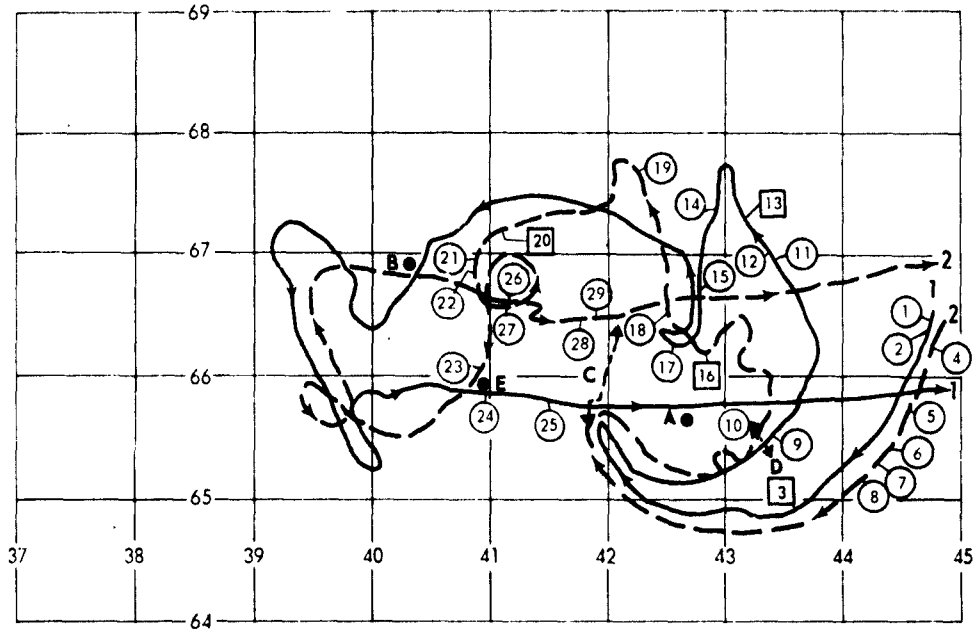


Fig C7—Reconstruction of Events in Run 2-2

1 and 2, OH-13, A, Tank, B, Jeep; C, Moving APC; D, Moving jeep; E, Infantry machinegun position; ◯, Ground, □, Air, Mission path: ——, helicopter 1; — —, helicopter 2; - - - -, C, D

Symbol	Event	Elapsed time, min : sec
(1)	A Acquires 1	6:26
(2)	A Fires at 1 (including simulator fire)	6:28
[3]	1 Acquires A	6:54
(4)	A Acquires 2	7:30
(5)	A Fires at 2	7:44
(6)	D Acquires 2	7:52
(7)	D Fires at 2	7:54
(8)	A Fires at 2	7:55
(9)	D Acquires 1, 2	11:08
(10)	D Fires at 2	11:09
(11)	E Acquires 1	13:30
(12)	C Acquires 1	13:31
[13]	1 Acquires C	13:40
(14)	B Acquires 1	15:04
(15)	B Fires at 1	15:36
[16]	2 Acquires C	18:02
(17)	C Acquires 2	18:28
(18)	C Fires at 2	18:32
(19)	E Acquires 2	22:04
[20]	2 Acquires B	24:56
(21)	B Acquires 2	25:12
(22)	B Fires at 2	25:14
(23)	E Acquires 2	27:48
(24)	E Acquires 1	30:08
(25)	E Fires at 1 (including firing blanks)	30:58
(26)	C Acquires 2	31:24
(27)	C Fires at 2	31:29
(28)	E Acquires 2	31:46
(29)	E Fires at 2 (including firing blanks)	31:47
	End of mission	31:55

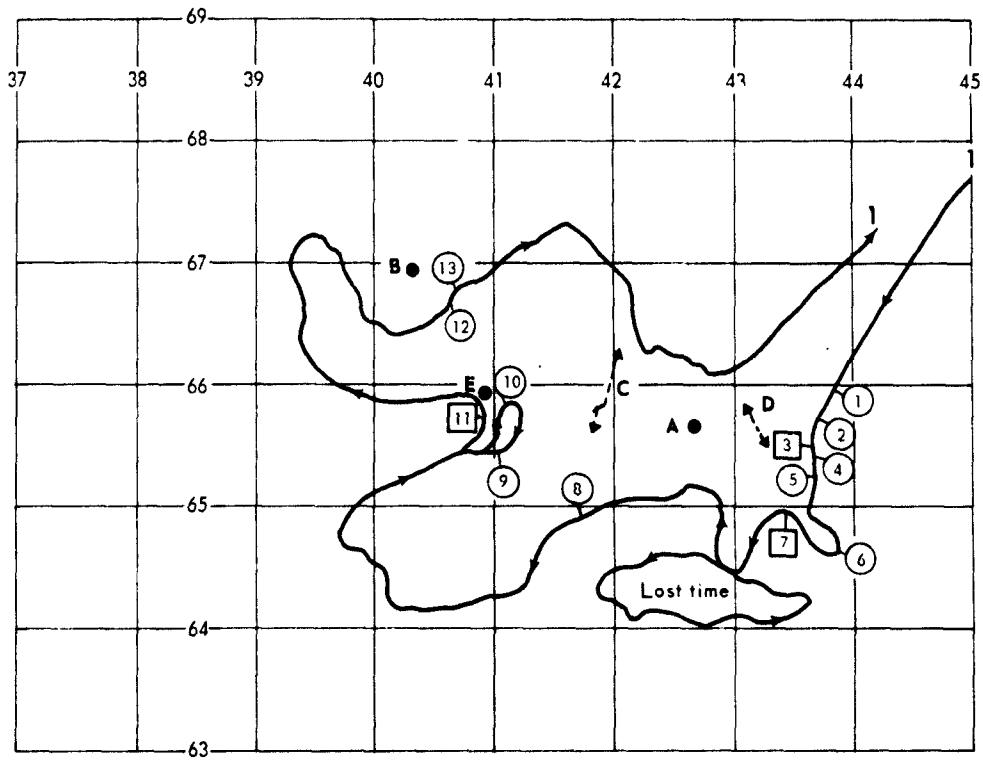


Fig. C8—Reconstruction of Events in Run 2-3

1, OH-13, A, Tank; B, Jeep; C, Moving APC; D, Moving jeep, E, Infantry machinegun position; ◯, Ground; □, Air; Mission path: ——, helicopter 1, - - - -, C, D

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min : sec
(1)	A Acquires 1	0:34	(8)	E Acquires 1	11:20
(2)	A Fires at 1 (including simulator fire)	0:37	(9)	E Acquires 1	16:12
[3]	1 Acquires A	0:38	(10)	E Fires at 1 (including firing blanks)	16:20
(4)	D Acquires 1	0:40	[11]	1 Acquires E	16:35
(5)	D Fires at 1	0:42	(12)	B Acquires 1	18:06
(6)	A Acquires 1	1:26	(13)	B Fires at 1	18:07
[7]	1 Acquires A	1:34		End of mission	24:00

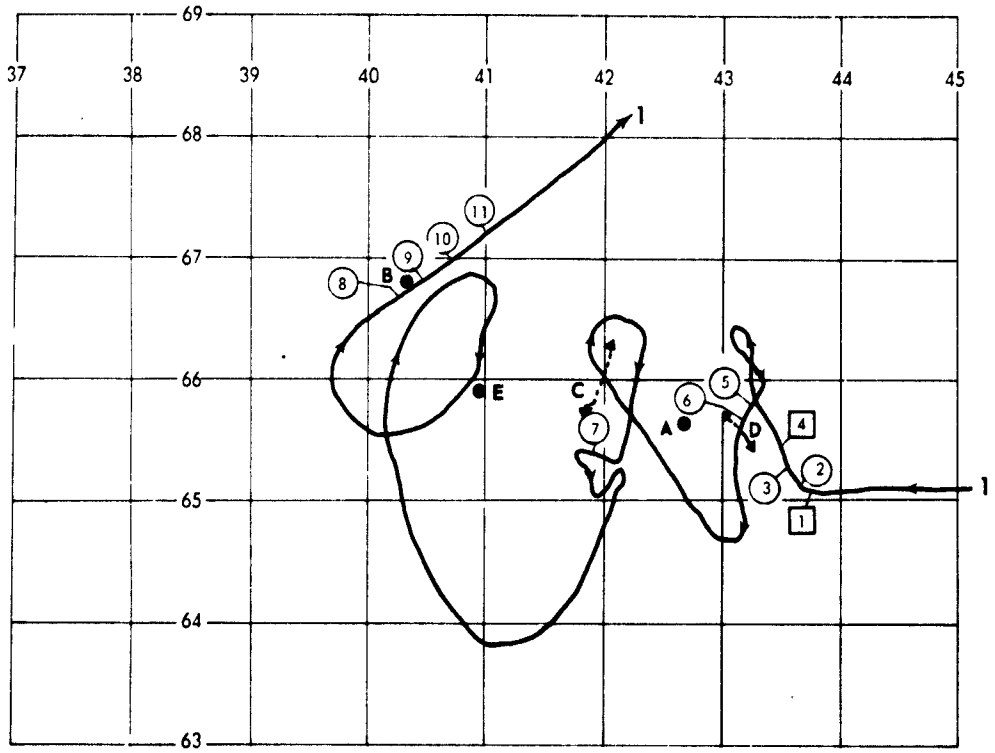


Fig C9—Reconstruction of Events in Run 2-4

1, OH-13, A, Tank; B, Jeep, C, Moving APC, D, Moving jeep, E, Infantry machinegun position; ◯, Ground, □, Air, Mission path ——, helicopter 1; —·—, C, D

Symbol	Event	Elapsed time, min sec
[1]	1 Acquires D	0:45
(2)	A Acquires 1	0 47
(3)	A Fires at 1 (including simulator fire)	0:49
[4]	1 Acquires A	0 51
(5)	D Acquires 1	1 27
(6)	D Fires at 1	1 28
(7)	E Acquires 1	3:56
(8)	B Acquires 1	10:00
(9)	B Fires at 1	10:01
(10)	C Acquires 1	10:14
(11)	C Fires at 1	10:32
	End of mission	11:00

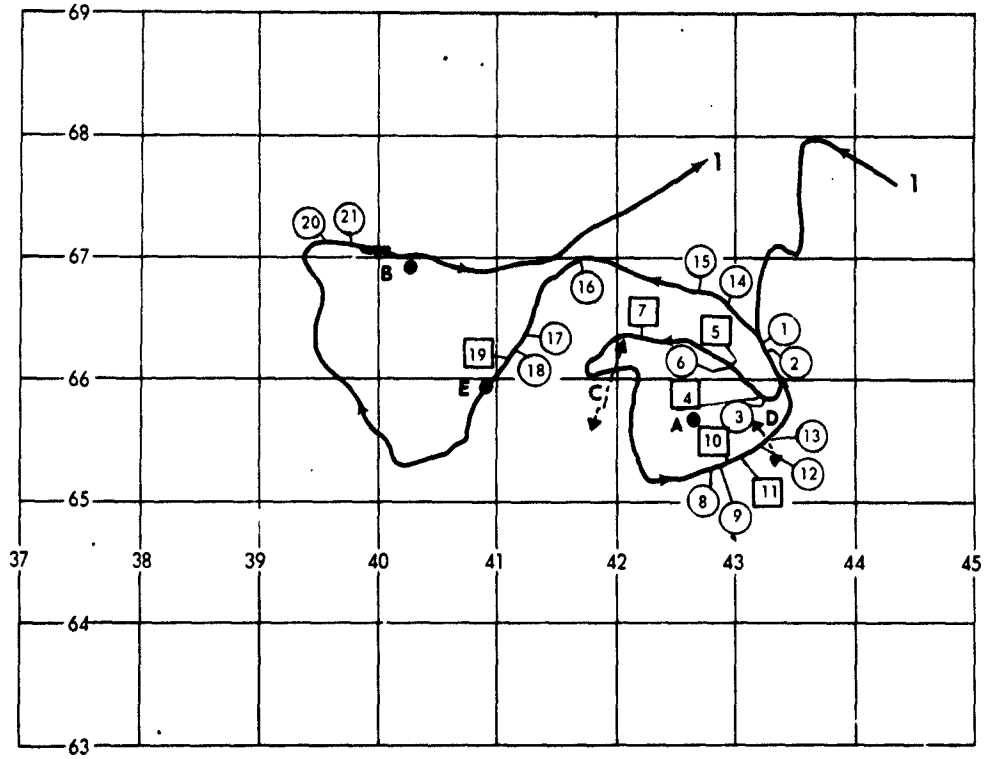


Fig. C10—Reconstruction of Events in Run 2-5

1, OH-13; A, Tank; B, Jeep; C, Moving APC; D, Moving jeep; E, Infantry machinegun position; ◯, C-round; □, Air; Mission path: ——, helicopter 1; — — —, C, D

Symbol	Event	Elapsed time, min : sec
(1)	D Acquires 1	1:54
(2)	D Fires at 1	1:56
(3)	A Acquires 1	2:53
[4]	1 Acquires A	2:54
[5]	1 Acquires D	2:56
(6)	A Fires at 1 (including simulator fire)	2:57
[7]	1 Acquires C	3:58
(8)	A Acquires 1	6:42
(9)	A Fires at 1 (including simulator fire)	6:44
[10]	1 Acquires A	6:45
[11]	1 Acquires D	6:46
(12)	D Acquires 1	6:52
(13)	D Fires at 1	6:53
(14)	C Acquires 1	8:01
(15)	C Fires at 1	8:17
(16)	B Acquires 1	8:42
(17)	E Acquires 1	9:04
(18)	E Fires at 1 (including firing blanks)	9:06
[19]	1 Acquires E	9:08
(20)	B Acquires 1	11:54
(21)	B Fires at 1	12:03
	End of mission	13:20

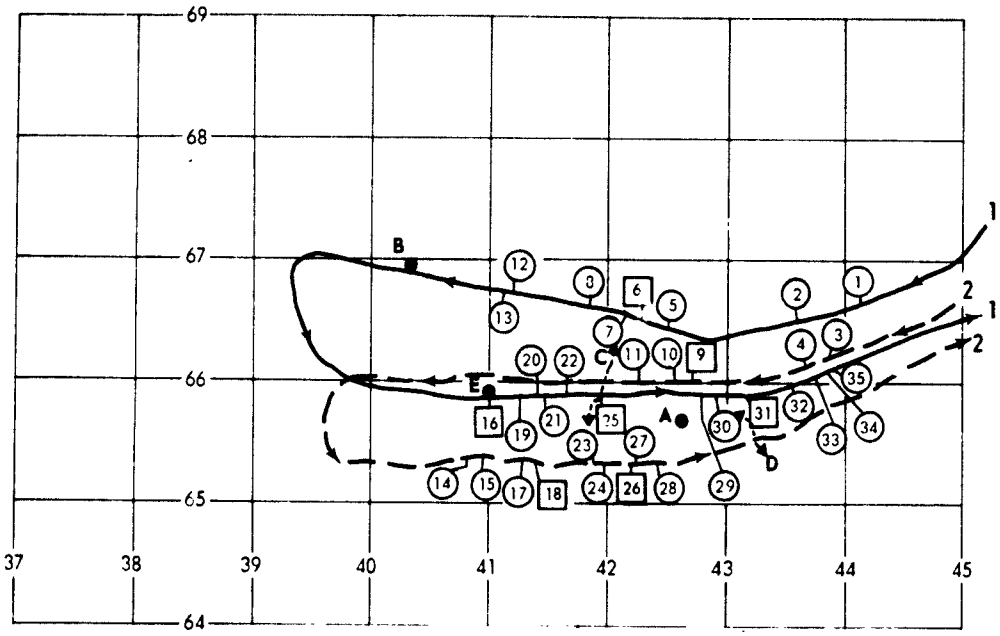


Fig. C11—Reconstruction of Events in Run 2-6

1 and 2, OH-13, A, Tank, B, Jeep, C, Moving APC; D, Moving Jeep, E, Infantry machinegun position, ◯, Ground; □, Air; Mission path: ——, helicopter 1, — — —, helicopter 2; — • — • —, C, D

Symbol	Event	Elapsed time, min.sec
①	D Acquires 1	0:37
②	A Acquires 1	1.00
③	D Acquires 2	1 04
④	D Fires at 2	1:10
⑤	E Acquires 1	1·19
⑥	1 Acquires C	1·22
⑦	C Acquires 1	1:24
⑧	E Fires at 1 (including firing blanks)	1 36
⑨	2 Acquires C	1 38
⑩	C Acquires 2	1:39
⑪	A Acquires 2	1:50
⑫	B Acquires 1	1:52
⑬	B Fires at 1	1.53
⑭	E Acquires 2	4.28
⑮	E Fires at 2 (including firing blanks)	4:30
⑯	1 Acquires E	4·40
⑰	C Acquires 2	4·42
⑱	2 Acquires E	4:44
⑲	E Acquires 1	4:44
⑳	E Fires at 1 (including firing blanks)	4.46
㉑	B Acquires 1	4:46
㉒	B Fires at 1	4:51
㉓	A Acquires 2	4:52
㉔	A Fires at 2	4·59
㉕	1 Acquires C	4.59
㉖	2 Acquires A	5:02
㉗	D Acquires 2	5:03
㉘	D Fires at 2	5:05
㉙	C Acquires 1	5:28
㉚	C Fires at 1	5:30
㉛	1 Acquires A	5:33
㉜	A Acquires 1	5 56
㉝	A Fires at 1 (including simulator fire)	6.00
㉞	D Acquires 1	6:00
㉟	D Fires at 1	6:01
	End of mission	7 00

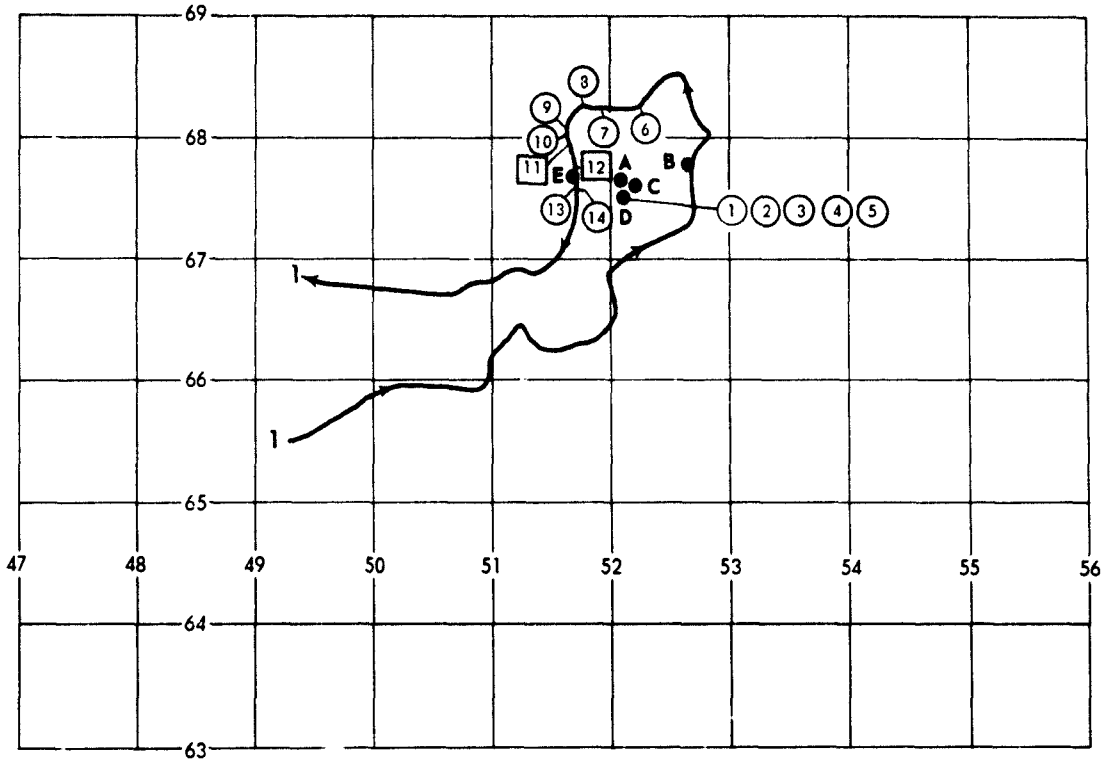


Fig. C12—Reconstruction of Events in Run 3-1

1, OH-13; A, Tank; B, Jeep; C, APC; D, Mortar APC; E, Jeep;
◯, Ground; □, Air; Mission path: ——, helicopter 1

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min : sec
(1)	D Fires simulator	1:40	(9)	A Acquires 1	28:45
(2)	D Fires simulator	4:50	(10)	A Fires at 1	28:46
(3)	D Fires simulator	11:28	[11]	1 Acquires E	28:48
(4)	D Fires simulator	18:15	[12]	1 Acquires A	28:58
(5)	D Fires simulator	21:28	(13)	D Acquires 1	29:00
(6)	E Acquires 1	28:24	(14)	C Fires at 1	29:04
(7)	E Fires at 1	28:32		End of mission	30:00
(8)	C Acquires 1	28:34			

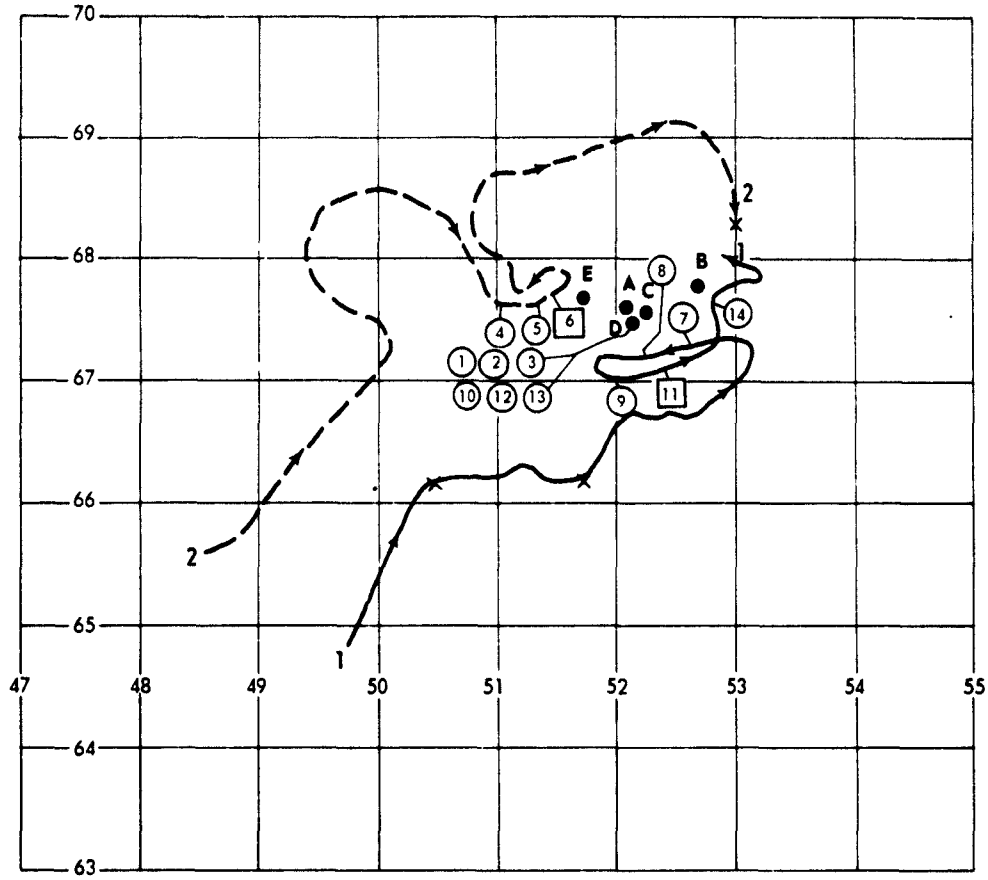


Fig. C13—Reconstruction of Events in Run 3-2

1 and 2, OH-13; A, Tank, B, Jeep; C, APC; D, Mortar APC; E, Jeep; X, Dismount position; ◯, Ground; □, Air; Mission path: ——, helicopter 1; — —, helicopter 2

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min . sec
①	D Fires simulator	0:34	⑨	A Acquires 1	11:12
②	D Fires simulator	3:50	⑩	D Fires simulator	11:26
③	D Fires simulator	5:52	⑪	1 Acquires E, A	12:12
④	E Acquires 2	8:05	⑫	D Fires simulator	13:12
⑤	E Fires at 2	8:20	⑬	D Fires simulator	14.26
⑥	2 Acquires E	8 24	⑭	E Acquires 1	15:02
⑦	B Acquires 1	10:09		End of missi n	19:00
⑧	D Acquires 1	10:26			

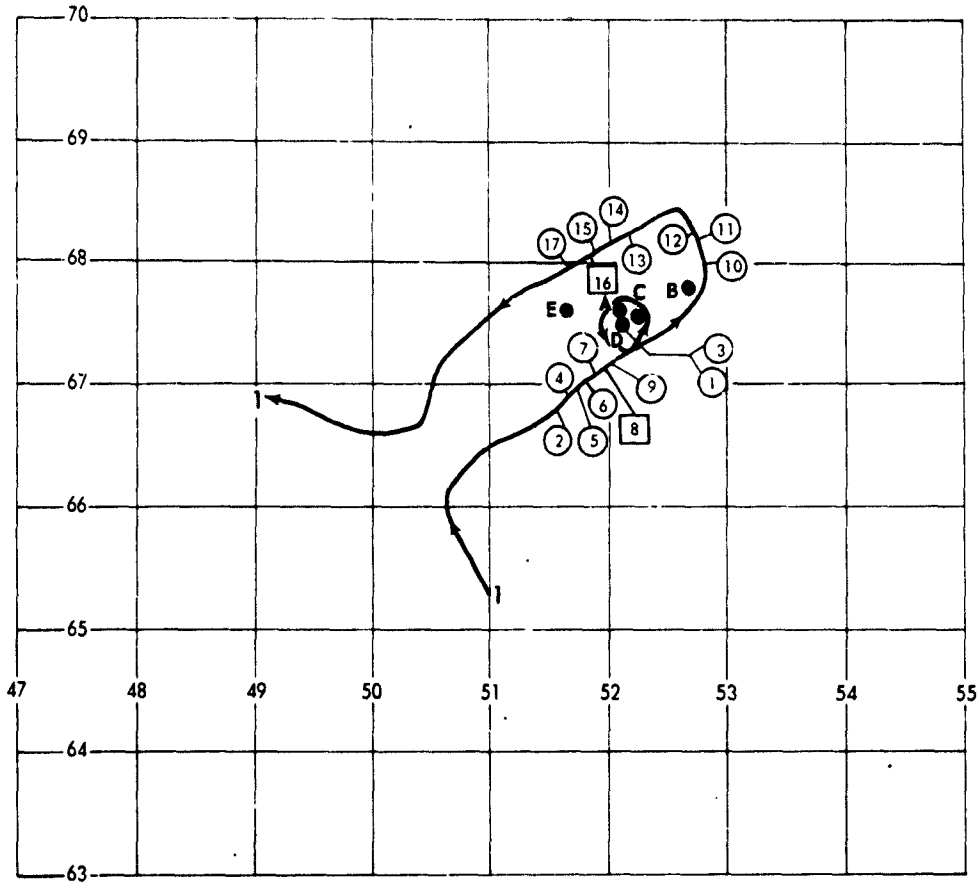


Fig. C14—Reconstruction of Events in Run 3-3

1, OH-13; A, Tank; B, Jeep; C, APC; D, Mortar APC; E, Jeep;
◯, Ground, □, Air; Mission path: ——, helicopter 1

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min : sec
(1)	D Fires simulator	0:32	(10)	E Acquires 1	9:00
(2)	D Acquires 1	5:45	(11)	C Acquires 1	9:08
(3)	D Fires simulator	5:52	(12)	C Fires at 1	9:10
(4)	B Acquires 1	5:57	(13)	A Acquires 1	9:42
(5)	E Acquires 1	6:00	(14)	E Fires at 1	9:51
(6)	C Acquires 1	6:03	(15)	A Fires at 1	9:56
(7)	A Acquires 1	6:12	[16]	1 Acquires E	9:57
[8]	1 Acquires A	6:13	(17)	D Acquires 1	10:04
(9)	B Fires at 1	6:14		End of mission	11:00

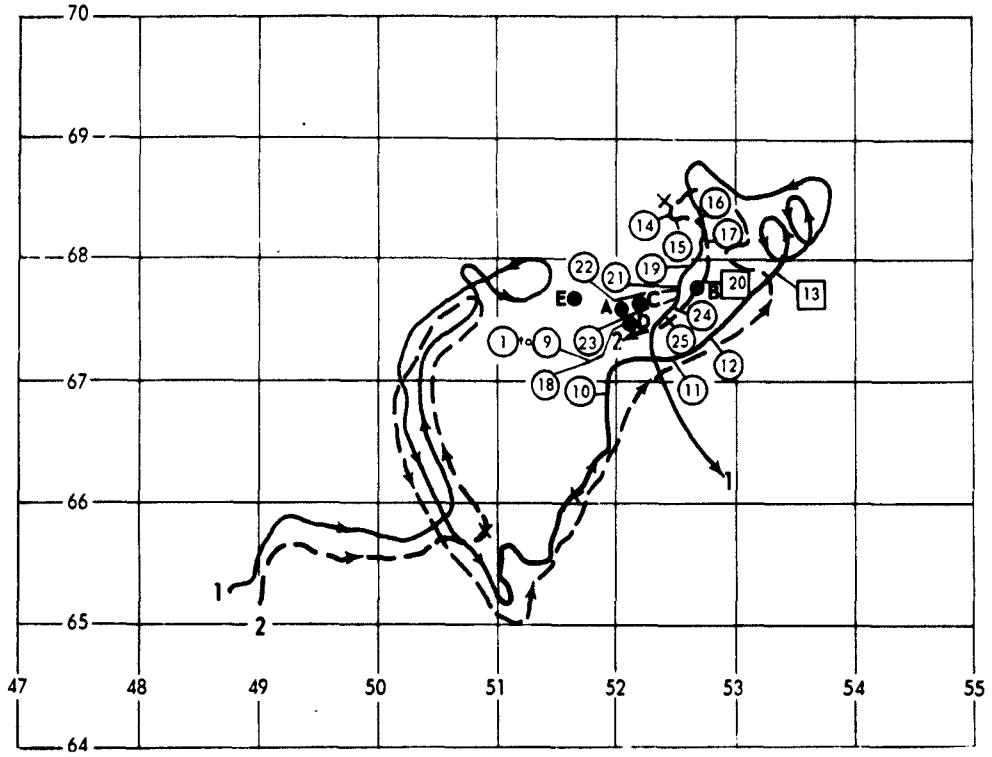


Fig. C15—Reconstruction of Events in Run 3-4

1 and 2, OH-13; A, Tank; B, Jeep, C, APC; D, Mortar APC; E, Jeep; X, Dismount position; ◯, Ground; □, Air; Mission path: ——, helicopter 1; — —, helicopter 2

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min : sec
(1)	D Fires simulator	0:36	(14)	B Acquires 2	67:24
(2)	D Fires simulator	7:15	(15)	C Acquires 2	67:29
(3)	D Fires simulator	12:02	(16)	A Acquires 2	67:33
(4)	D Fires simulator	18:14	(17)	B Fires at 2	67:40
(5)	D Fires simulator	20:29	(18)	D Fires simulator	67:52
(6)	D Fires simulator	22:29	(19)	B Acquires 1	67:53
(7)	D Fires simulator	29:00	[20]	2 Acquires D, A	68:00
(8)	D Fires simulator	34:52	(21)	B Fires at 1	68:05
(9)	D Fires simulator	39:10	(22)	D Acquires 1	68:06
(10)	D Acquires 1	45:00	(23)	E Acquires 1	68:08
(11)	E Acquires 1	51.23	(24)	E Acquires 2	68:12
(12)	B Acquires 1	52:08	(25)	D Acquires 2	68:14
[13]	2 Acquires A	54:05		End of mission	68:20

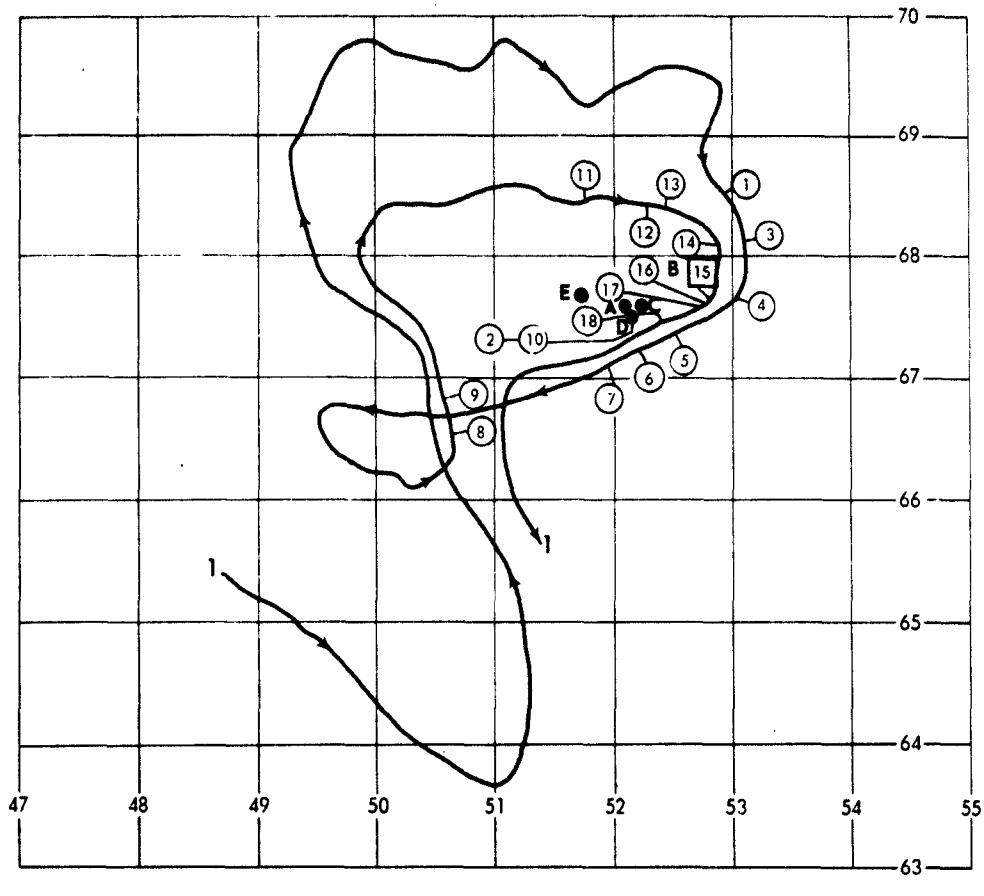


Fig. C16—Reconstruction of Events in Run 3-5

1, OH-13; A, Tank; B, Jeep; C, APC; D, Mortar APC; E, Jeep;
◯, Ground, □, Air; Mission path: ——, helicopter 1

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min : sec
(1)	E Acquires 1	0:32	(11)	E Acquires 1	8:12
(2)	D Fires simulator	0:38	(12)	C Acquires 1	8:52
(3)	C Acquires 1	0:54	(13)	E Fires at 1	9:01
(4)	B Acquires 1	1:16	(14)	B Acquires 1	9:38
(5)	D Acquires 1	1:28	[15]	1 Acquires B	9:57
(6)	A Acquires 1	1:36	(16)	D Acquires 1	9:59
(7)	A Fires at 1	1:47	(17)	A Acquires 1	10:00
(8)	A Acquires 1	5:46	(18)	A Fires at 1	10:10
(9)	A Fires at 1	6:03		End of mission	11:00
(10)	D Fires simulator	6:36			

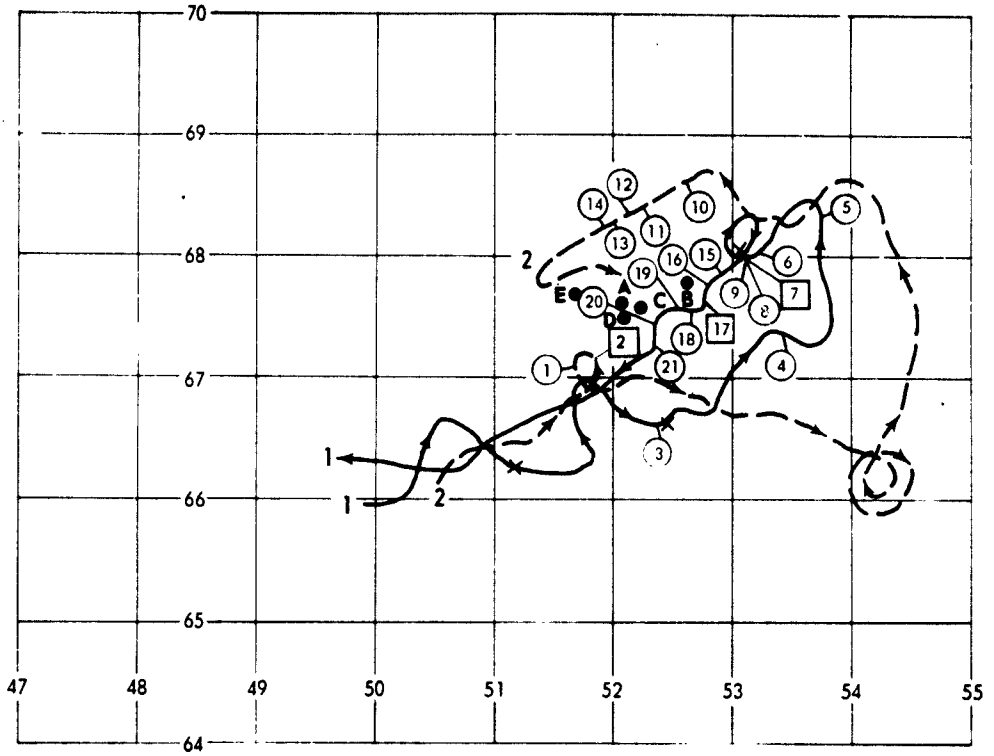


Fig. C17—Reconstruction of Events in Run 3-6

1 and 2, OH-13; A, Tank; B, Jeep, C, APC, D, Mortar APC, E, Jeep, X, Dismount position, ◯, Ground; □, Air; Mission path: ——, helicopter 1, — —, helicopter 2

Symbol	Event	Elapsed time, min . sec	Symbol	Event	Elapsed time, min sec
(1)	D Acquires 2	1:00	(12)	B Fires at 2	36.32
[2]	2 Acquires D	1.06	(13)	E Acquires 2	36:40
(3)	D Acquires 1	10:34	(14)	E Fires at 2	36 42
(4)	E Acquires 1	25:40	(15)	B Acquires 1	37:04
(5)	C Acquires 1	33:07	(16)	C Acquires 1	37 10
(6)	A Acquires 1	33.35	[17]	1 Acquires A, C, D	37 14
[7]	1 Acquires B	33.42	(18)	C Fires at 1	37 16
(8)	B Acquires 1	34 40	(19)	D Acquires 1	37.20
(9)	B Fires at 1	34:45	(20)	A Acquires 1	37:28
(10)	A Acquires 2	35:54	(21)	A Fires at 1	37:33
(11)	B Acquires 2	36:28		End of mission	38:00

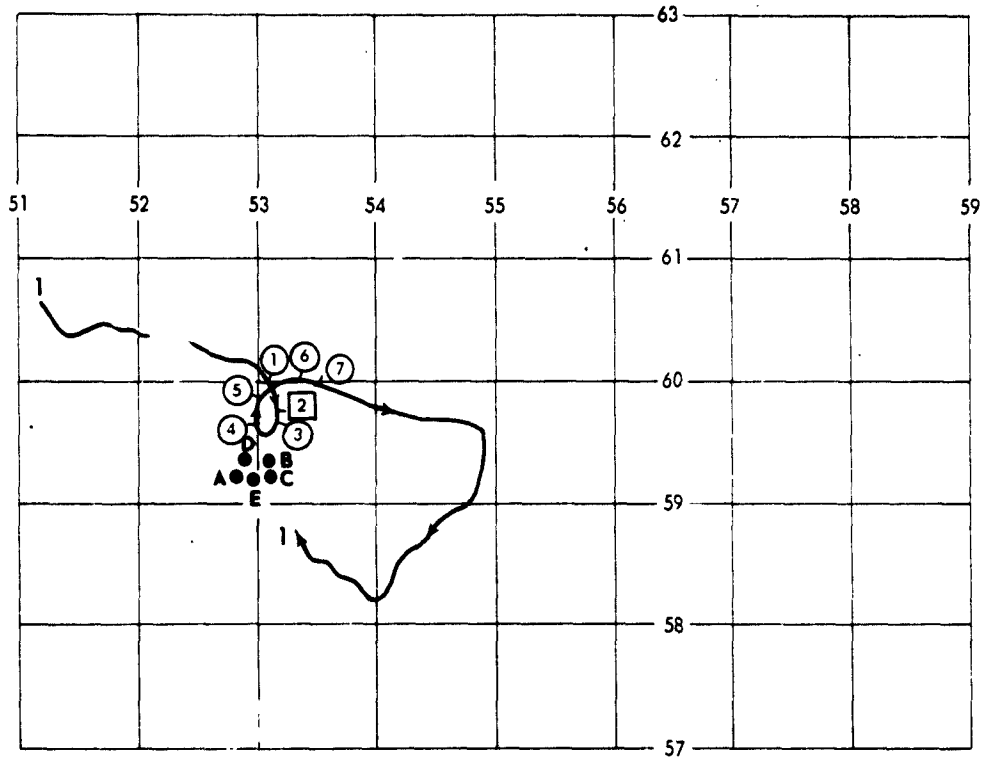


Fig. C18—Reconstruction of Events in Run 4-1

1, OH-13; A, Tank; B, Jeep; C, Infantry machinegun position; D, APC; E, Jeep;
◯, Ground; □, Air; Mission path: ——, helicopter 1

Symbol	Event	Elapsed time, min : sec
(1)	C Acquires 1	3:52
[2]	1 Acquires A, D	3:56
(3)	A Acquires 1	3:56
(4)	D Acquires 1	3:58
(5)	B Acquires 1	4:00
(6)	D Fires at 1	4:03
(7)	A Fires at 1	4:05
	End of mission	6:00

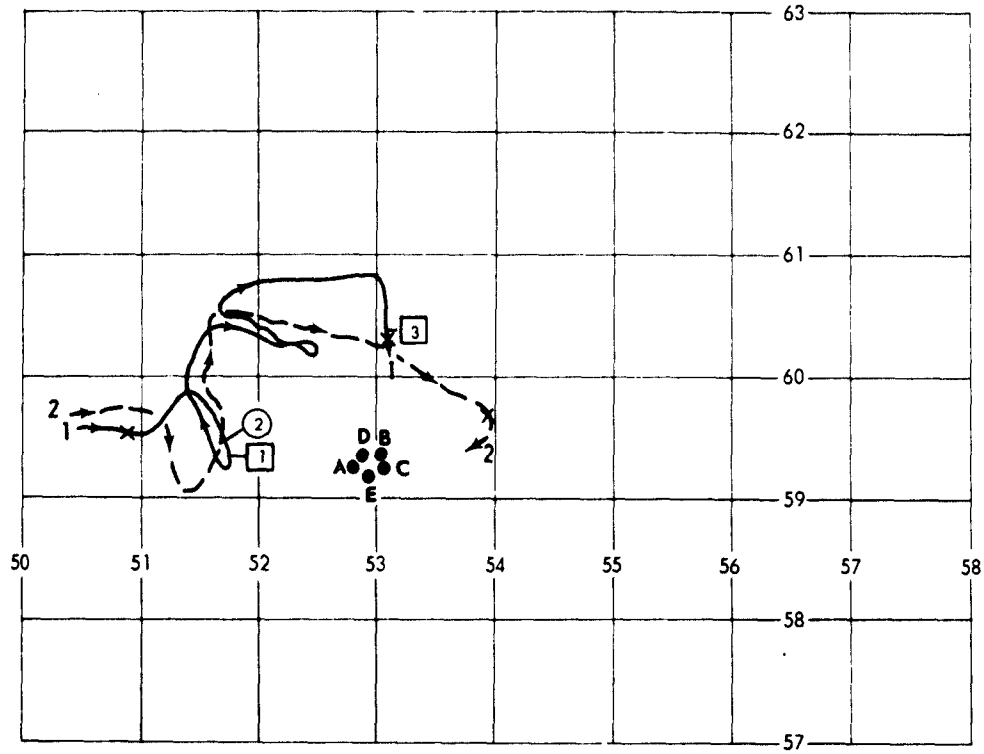


Fig. C19—Reconstruction of Events in Run 4-2

1 and 2, OH-13; A, Tank; B, Jeep; C, Infantry machinegun position; D, APC, E, Jeep; X, Dismount position; ◯, Ground; □, Air; Mission path: ——— helicopter 1; — — —, helicopter 2

Symbol	Event	Elapsed time, min : sec
1	1 Acquires A	28:04
2	A Acquires 2	44:34
3	1 Acquires A, D, C	61:08
	End of mission	62:00

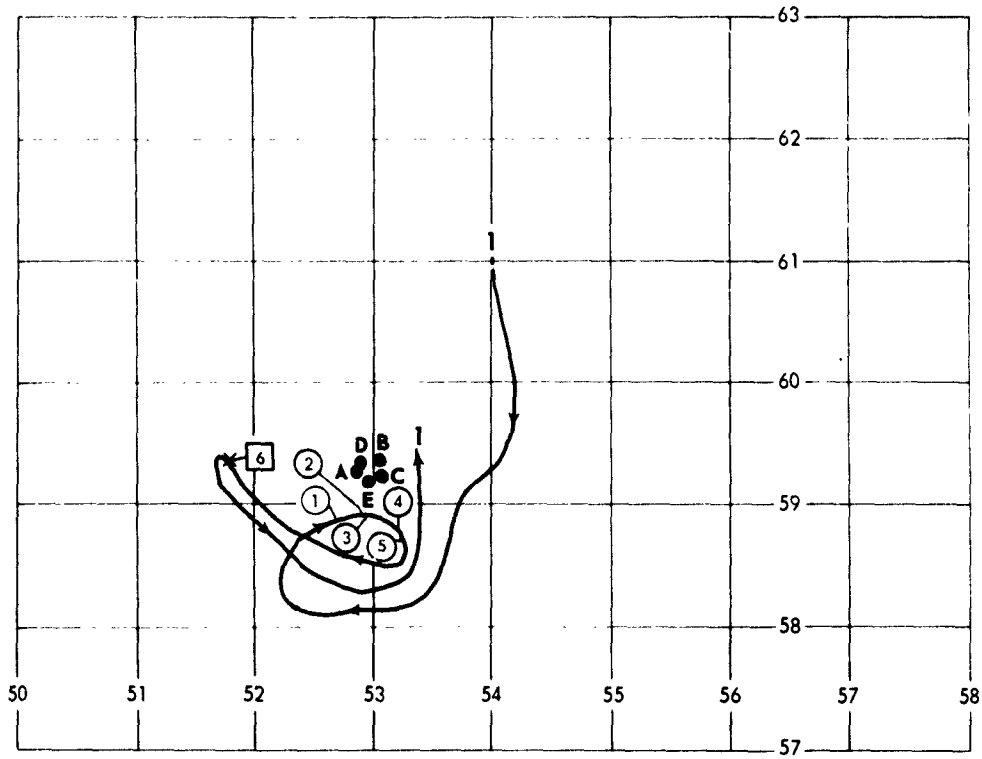


Fig. C20—Reconstruction of Events in Run 4-3

1, OH-13; A, Tank, B, Jeep; C, Infantry machinegun position; D, APC, E, Jeep; X, Dismount position; ◯, Ground; □, Air; Mission path: ——, helicopter 1

Symbol	Event	Elapsed time, min : sec
①	E Acquires 1	43:01
②	C Acquires 1	43:12
③	C Fires at 1 (including firing blanks)	43:14
④	B Acquires 1	43:20
⑤	B Fires at 1	43:22
⑥	1 Acquires D	52:22
	End of mission	54:00

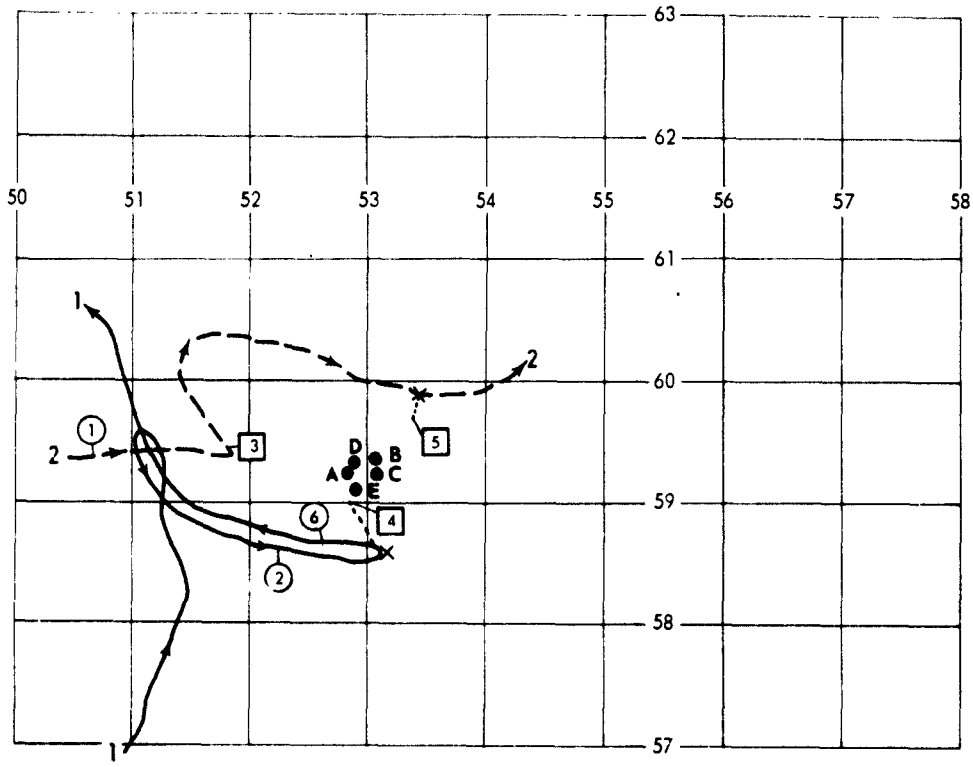


Fig. C21—Reconstruction of Events in Run 4-4

1 and 2, OH-13, A, Tank; B, Jeep; C, Infantry machinegun position; D, APC; E, Jeep, X, Dismount position; ◯, Ground; □, Air; Mission path: ——, helicopter 1, — —, helicopter 2; - - - -, Observer on foot

Symbol	Event	Elapsed time, min . sec
(1)	A Acquires 2	0:25
(2)	E Acquires 1	6 30
[3]	2 Acquires A	16:55
[4]	1 Acquires E	28:00
[5]	2 Acquires C	31:18
(6)	E Acquires 1	31:36
	End of mission	42:00

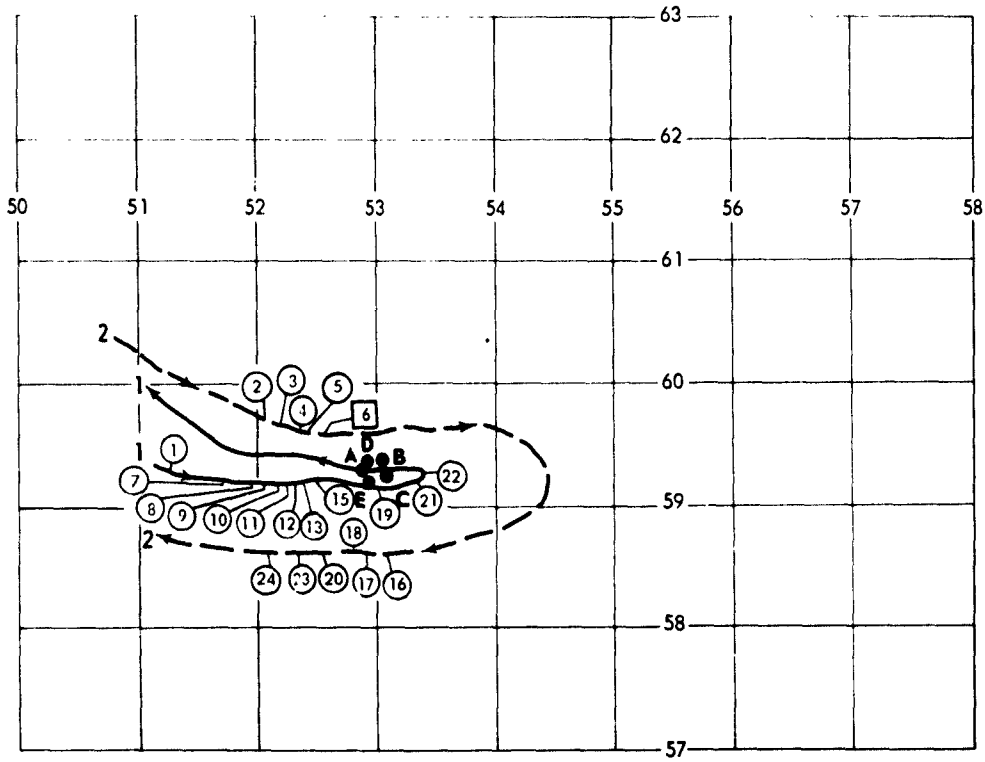


Fig. C22—Reconstruction of Events in Run 4-5

1 and 2, OH-13; A, Tank, B, Jeep; C, Infantry machinegun position; D, APC; E, Jeep; ◯, Ground; □, Air; Mission path: ——, helicopter 1; — —, helicopter 2

Symbol	Event	Elapsed time, min : sec	Symbol	Event	Elapsed time, min : sec
①	A Acquires 1	1:40	⑮	D Acquires 1	4:13
②	A Acquires 2	3:32	⑯	A Acquires 2	4:32
③	B Acquires 2	3:37	⑰	A Fires at 2	4:38
④	A Fires at 2	3:46	⑱	C Acquires 2	4:40
⑤	B Fires at 2	3:46	⑲	E Acquires 1	4:48
□6	2 Acquires A, D	3:52	⑳	C Fires at 2 (including	
⑦	A Acquires 1	3:54		firing blanks)	4:52
⑧	A Fires at 1	4:00	㉑	C Acquires 1	5:20
⑨	B Acquires 1	4:01	㉒	C Fires at 1 (including	
⑩	C Acquires 1	4:04		firing blanks)	5:24
⑪	D Acquires 1	4:06	㉓	D Acquires 2	5:32
⑫	E Acquires 1	4:08	㉔	D Fires at 2	5:50
⑬	B Fires at 1	4:10		End of mission	6:00

*No event 14.

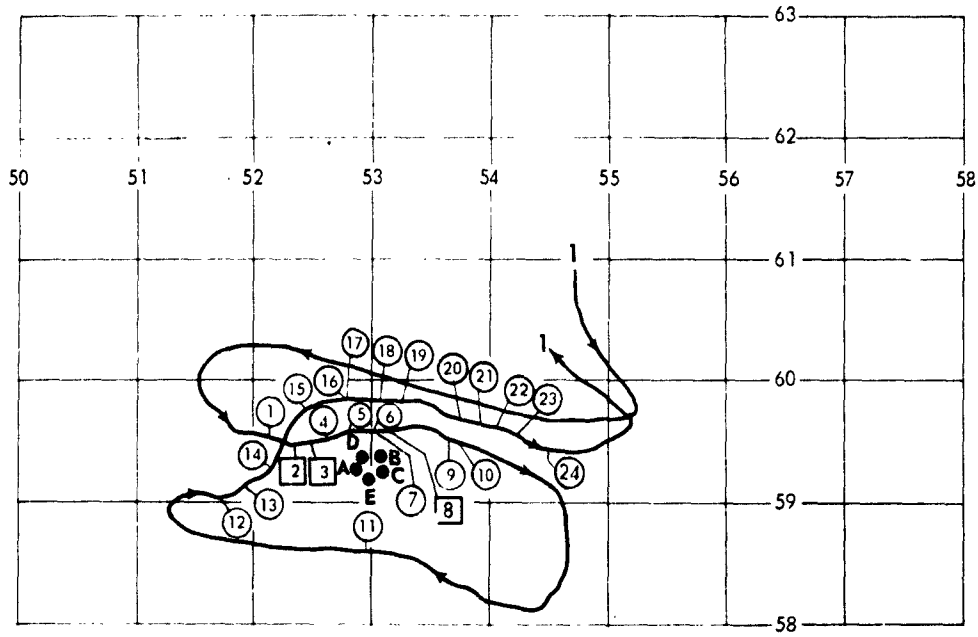


Fig. C23—Reconstruction of Events in Run 4-6

1, OH-13, A, Tank; B, Jeep, C, Infantry machinegun position, D, APC, E, Jeep;
○, Ground, □, Air, Mission path. ——, helicopter 1

Symbol	Event	Elapsed time, min sec
(1)	A Acquires 1	8 03
[2]	1 Acquires A	8 14
[3]	1 Acquires D	8:16
(4)	D Acquires 1	8 17
(5)	B Acquires 1	8.22
(6)	C Acquires 1	8.23
(7)	E Acquires 1	8.23
[8]	1 Acquires B	8 23
(9)	B Fires at 1	8 28
(10)	C Fires at 1 (including firing blanks)	8.32
(11)	E Acquires 1	11.24
(12)	A Acquires 1	12 02
(13)	D Acquires 1	12:08
(14)	A Fires at 1	12:14
(15)	D Acquires 1	13:14
(16)	A Acquires 1	13:33
(17)	D Acquires 1	13:35
(18)	D Fires at 1	13:39
(19)	A Fires at 1	13:41
(20)	E Acquires 1	13 54
(21)	B Acquires 1	13:56
(22)	C Acquires 1	14:00
(23)	B Fires at 1	14:03
(24)	C Fires at 1 (including firing blanks)	14 09
	End of mission	14:30

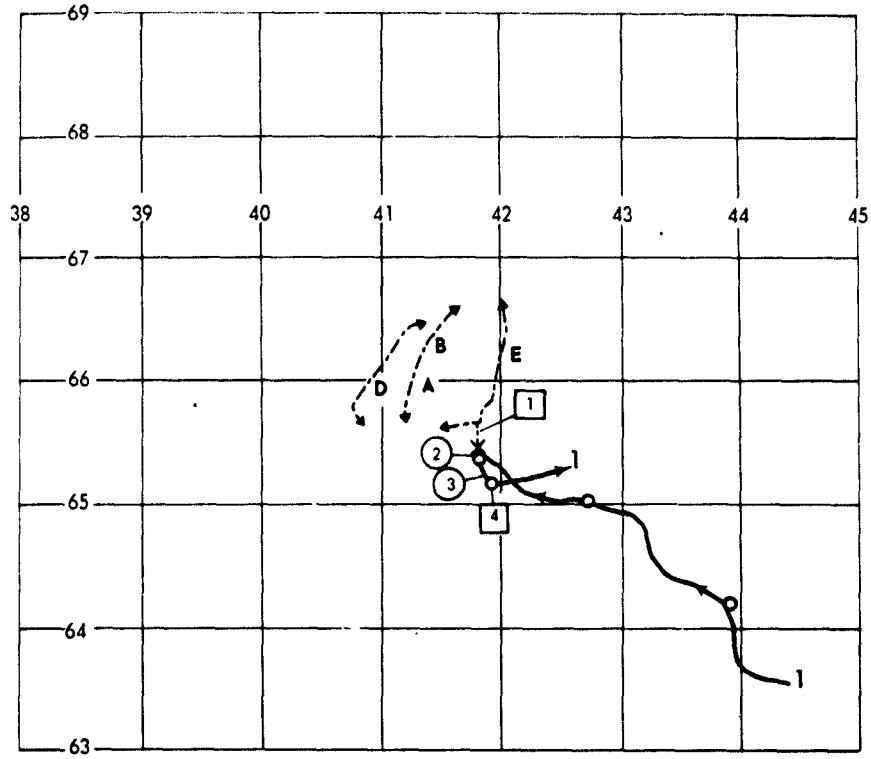


Fig. C24—Reconstruction of Events in Run 5-1

1, OH-13; A. Moving APC; B, Moving APC; D, Moving jeep; E, Moving jeep; X, Dismount position; O, Pop-up position; ◯, Ground; □, Air; Mission path: ——, helicopter 1, - - - - -, Observer on foot; —·—,A, B; —··—, D;E

Symbol	Event	Elapsed time, min : sec
1	1 Acquires E	4:56
2	E Acquires 1	5:00
3	E Fires at 1	6:10
4	1 Acquires A, B	6:14
	End of mission	8:00

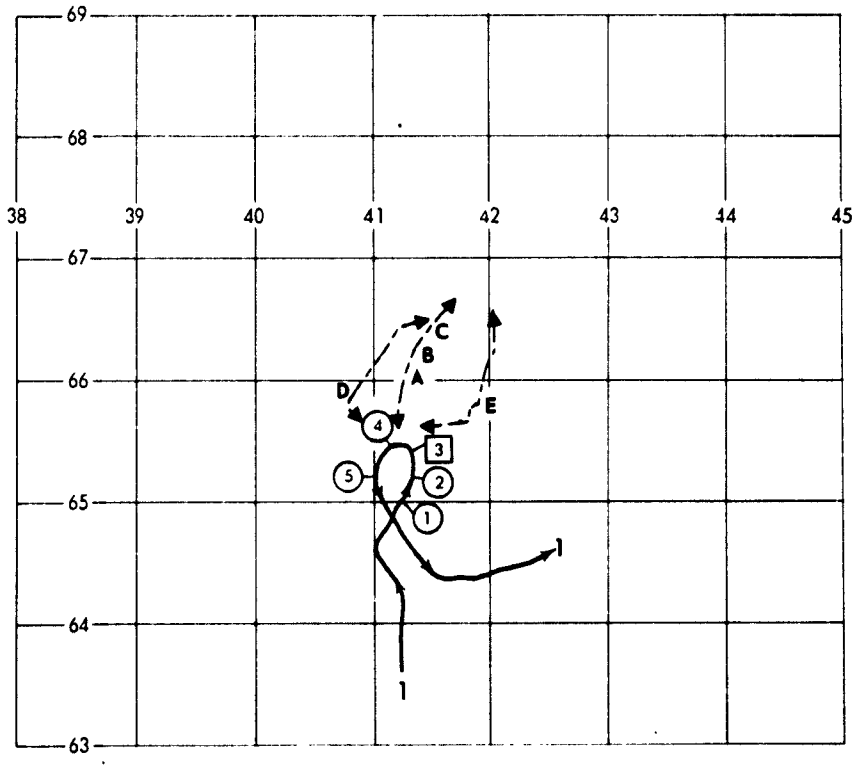


Fig. C25—Reconstruction of Events in Run 5-2

1 and 2, OH-13, A, Moving APC; B, Moving APC; C, Moving APC; D, Moving jeep, E, Moving jeep; ◯, Ground; □, Air, Mission path: ——, helicopter 1, — - —, A,B,C;D,E

Symbol	Event	Elapsed time, min : sec
(1)	A Acquires 1	8:42
(2)	C Acquires 1	8:52
[3]	1 Acquires A, B	9:01
(4)	B Acquires 1	9:04
(5)	D Acquires 1	9:13
	End of mission	10:00

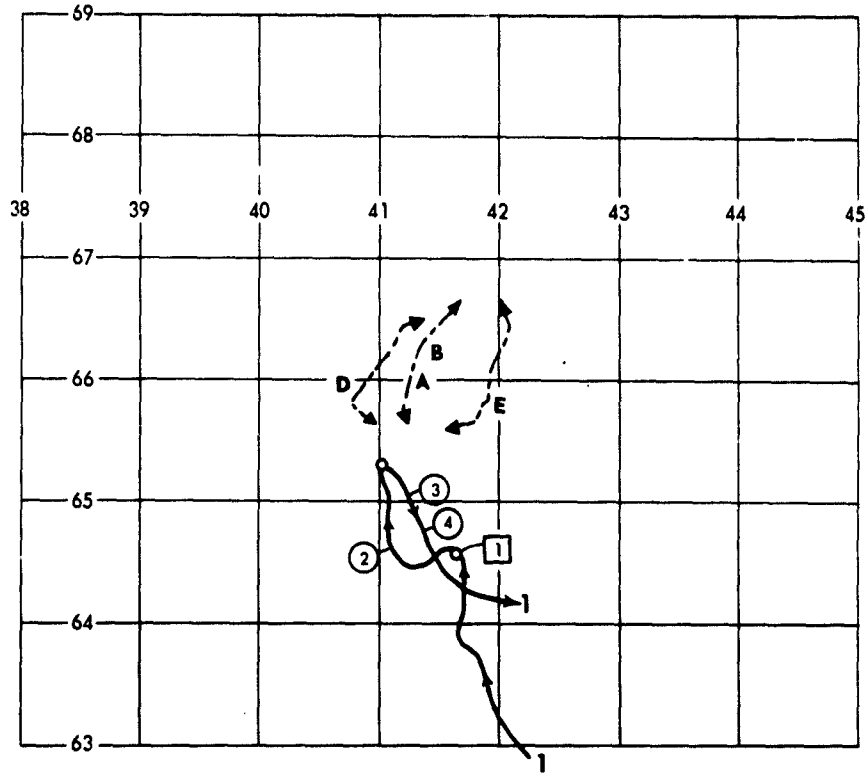


Fig. C26—Reconstruction of Events in Run 5-3

1, OH-13; A, Moving APC; B, Moving APC; D, Moving jeep; E, Moving jeep, O, Pop-up position; ◯, Ground; □, Air; Mission path: ——, helicopter 1; —•—, A, B; D; E

Symbol	Event	Elapsed time, min : sec
1	1 Acquires A	0:42
2	D Acquires 1	1:36
3	A Acquires 1	4:40
4	D Acquires 1	4:47
	End of mission	7:00

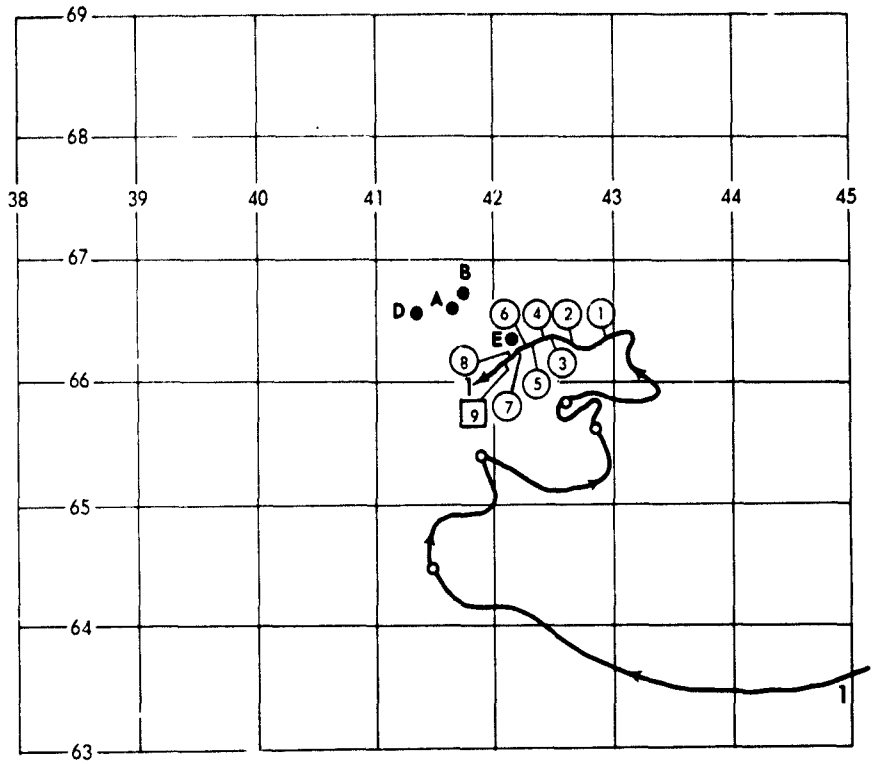


Fig. C27—Reconstruction of Events in Run 5-4

Moving column had completed move prior to helicopter arrival and was in assembly area.

1. OH-13; A, APC; B, APC; D, Jeep; E, Jeep; O Pop-up position; ◯, Ground; □, Air; Mission path: ——, helicopter 1

Symbol	Event	Elapsed time, min : sec
(1)	A Acquires 1	40:31
(2)	A Fires at 1	40:42
(3)	D Acquires 1	40:46
(4)	D Fires at 1	40:48
(5)	B Acquires 1	41:10
(6)	B Fires at 1	41:14
(7)	E Acquires 1	41:14
(8)	E Fires at 1	41:16
[9]	1 Acquires A, B	41:42
	End of mission	42:00

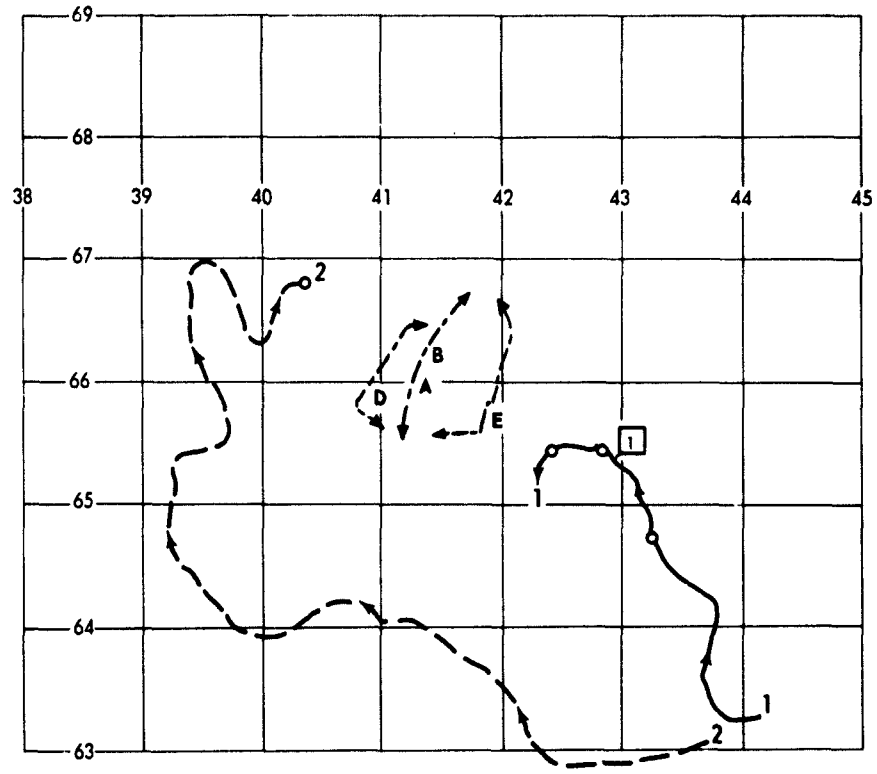


Fig. C28—Reconstruction of Events in Run 5-5

1 and 2, OH-13; A, Moving APC; B, Moving APC; D, Moving jeep; E, Moving jeep; O, Pop-up position; ◯, Ground; □, Air; Mission path: ——, helicopter 1; — —, helicopter 2; — - —, A, B; D; E

Symbol	Event	Elapsed time, min : sec
[1]	1 Acquires A, B	10:55
	End of mission	15:00

Appendix D

GUN-CAMERA LAY

Figures

As a by-product of the principal objective the experiment—determining the effectiveness of several reconnaissance techniques—a considerable body of data was generated concerning the accuracy of gun lay against the OH-13 helicopter. Camera procedures, conditions under which firings occurred, center-of-mass aiming-point constraint, and film-reading methods are discussed in the main body of the report.

The data are grouped first by weapon and weapon mount and then by engagement range in 250-m increments. The following Figs. D1–D32 show the frequency distributions of horizontal and vertical lay errors, measured in mils, of weapons used in the experiment as represented in individual frames of film (taken at 16 frames/sec).

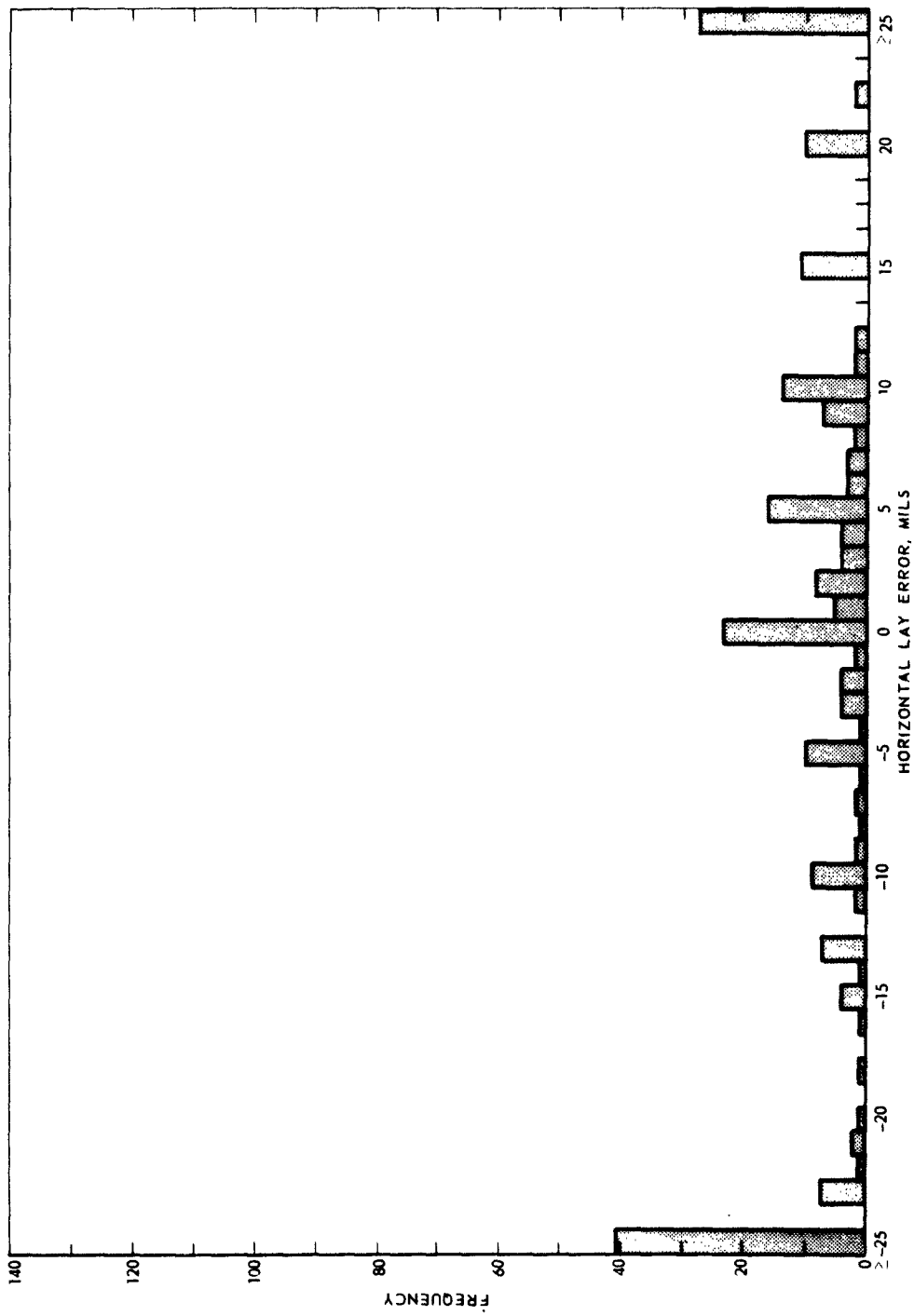


Fig. D1—Frequency Distribution of Horizontal Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 0–250 m: $n = 249$

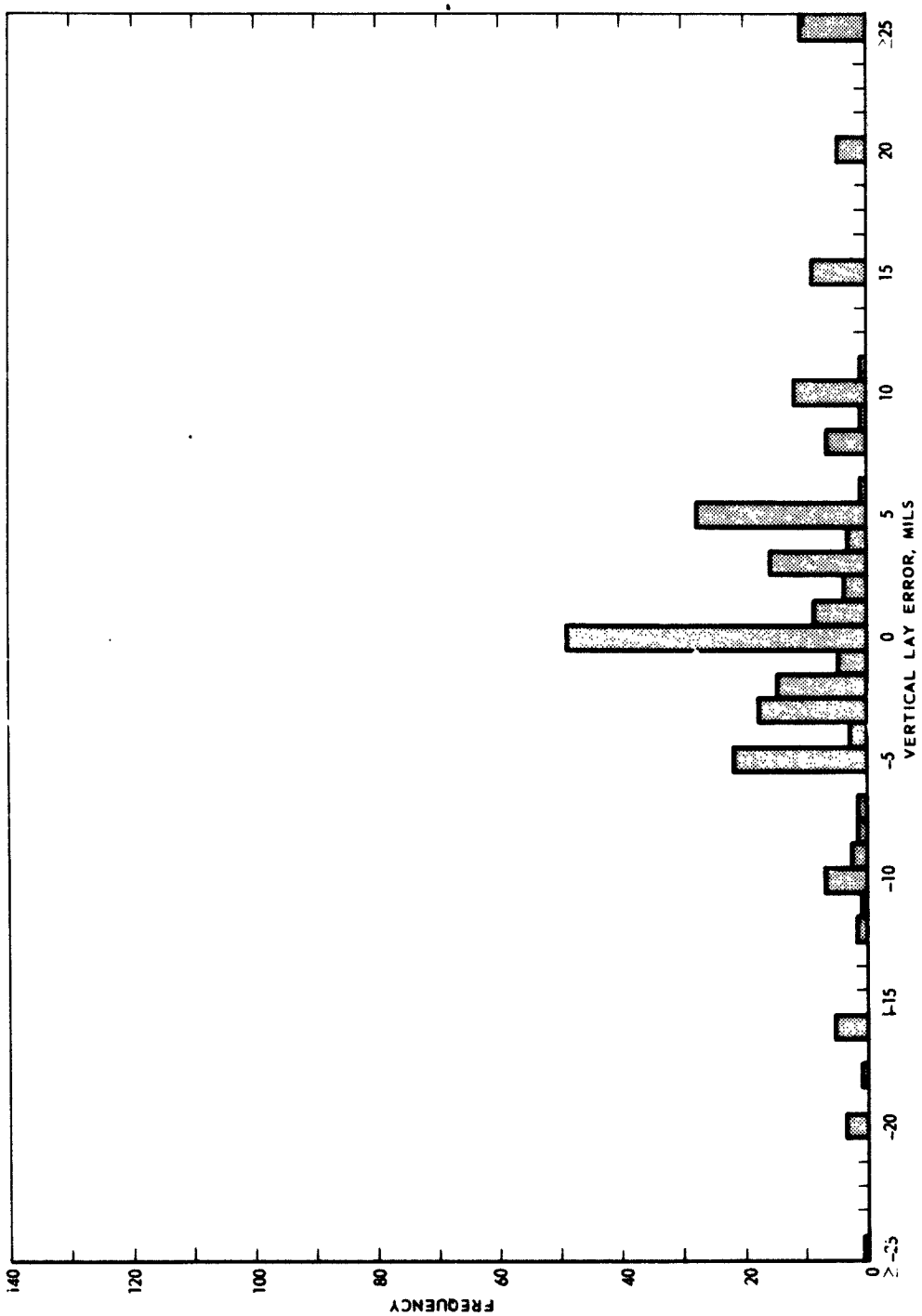


Fig. D2—Frequency Distribution of Vertical Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 0–250 m: $n = 249$

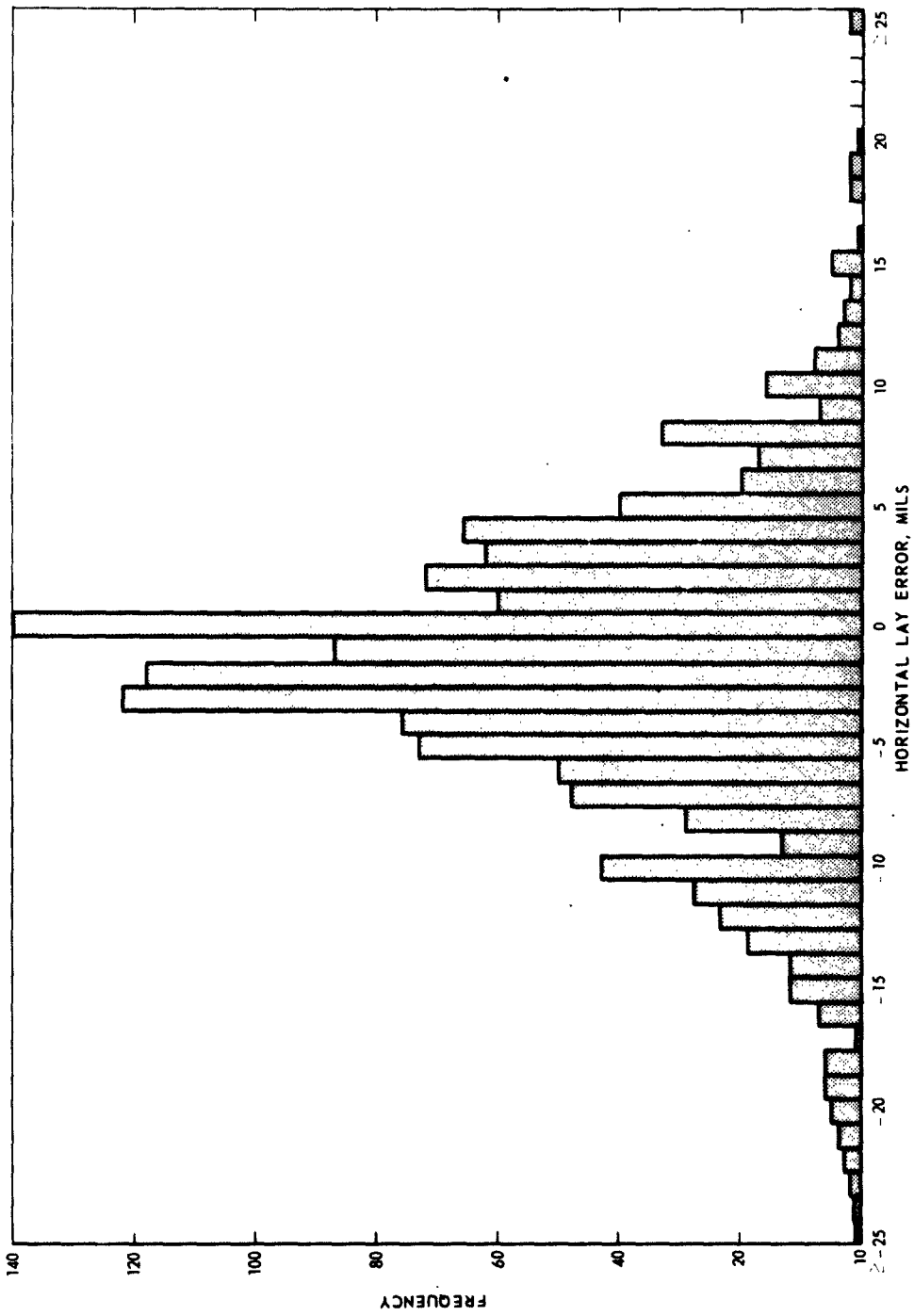


Fig. D3—Frequency Distribution of Horizontal Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 300–500 m: $n = 1355$

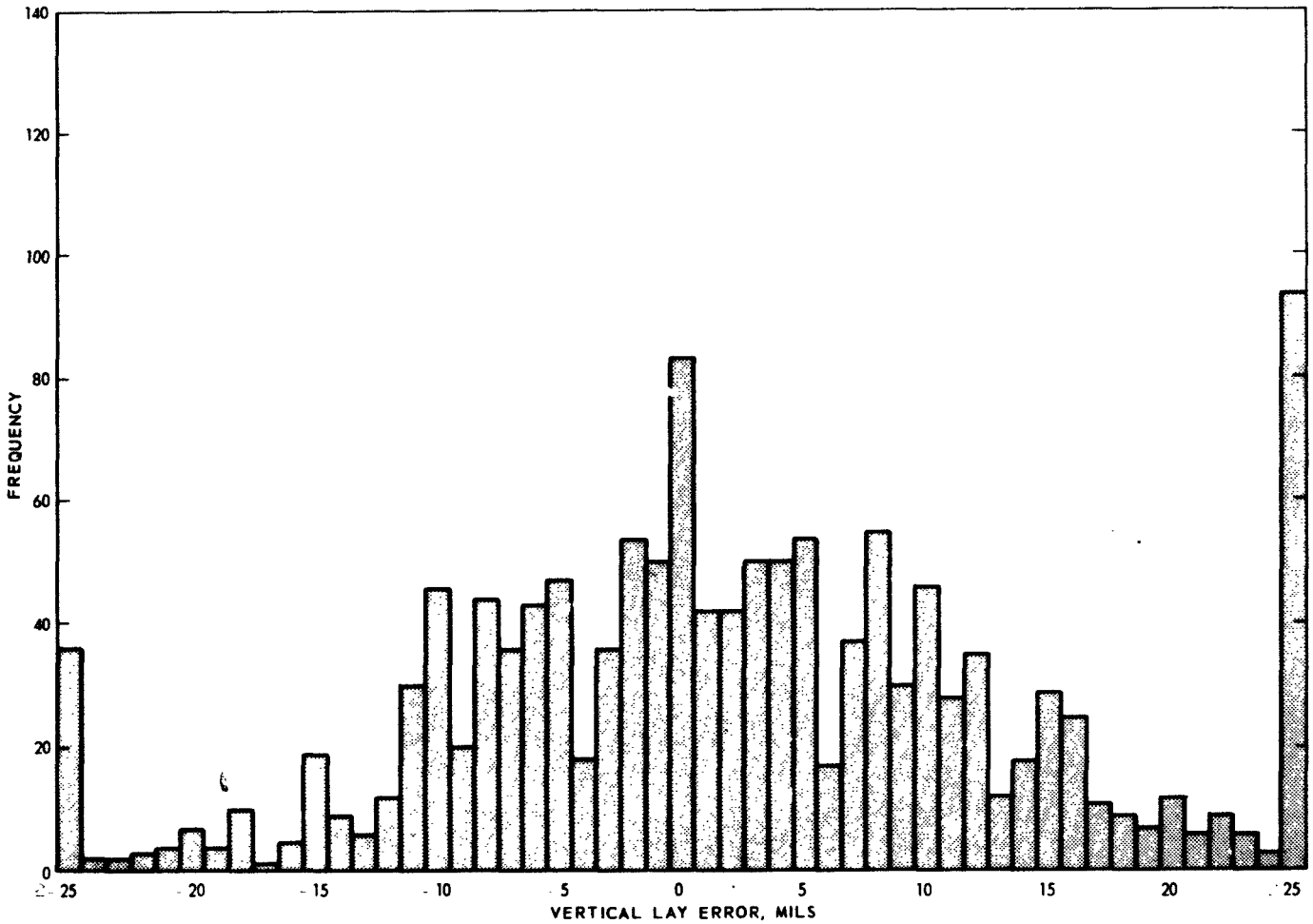


Fig. D4—Frequency Distribution of Vertical Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 300–500 m: n = 1355

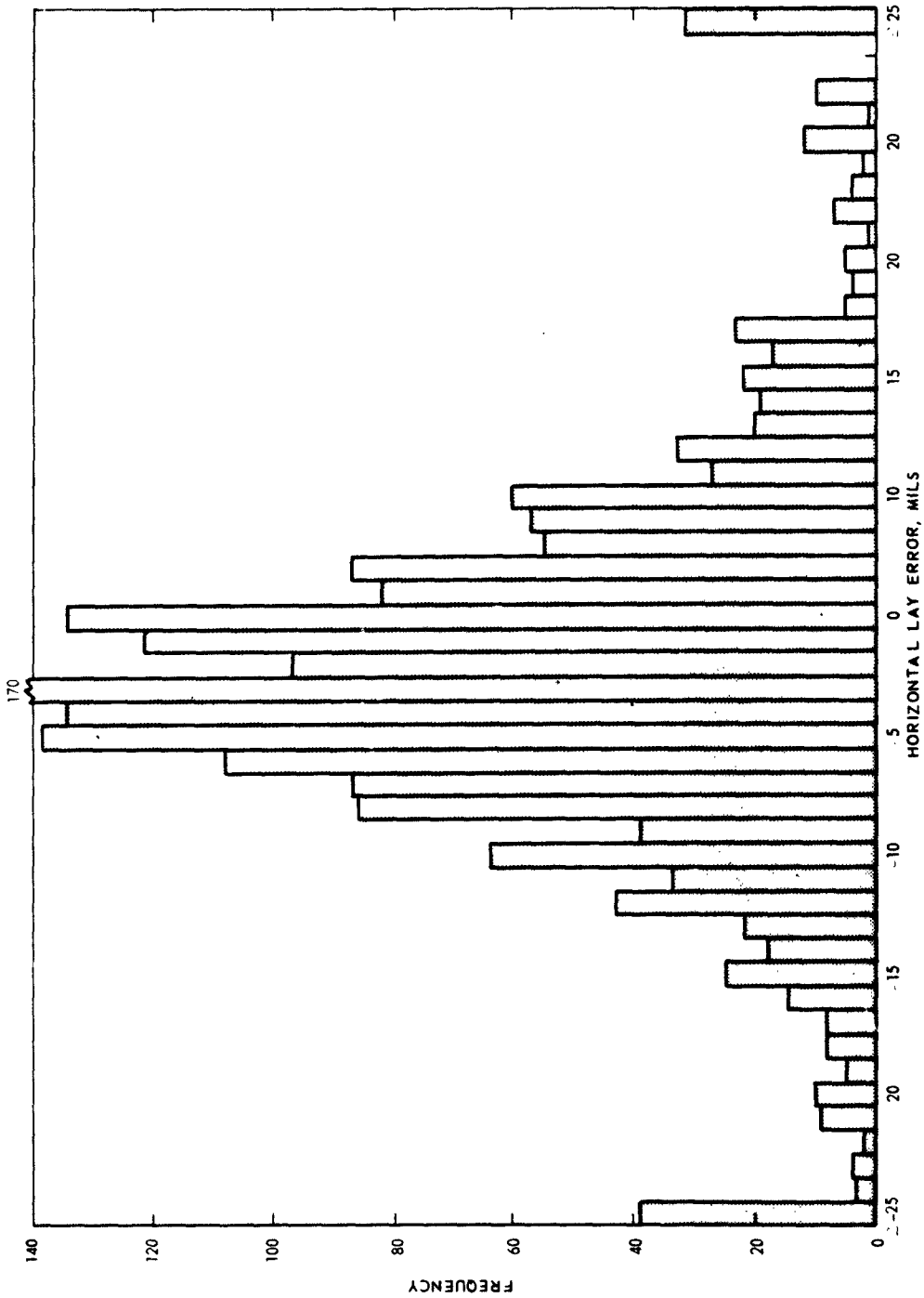


Fig. D5—Frequency Distribution of Horizontal Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 550–750 m: n = 1951

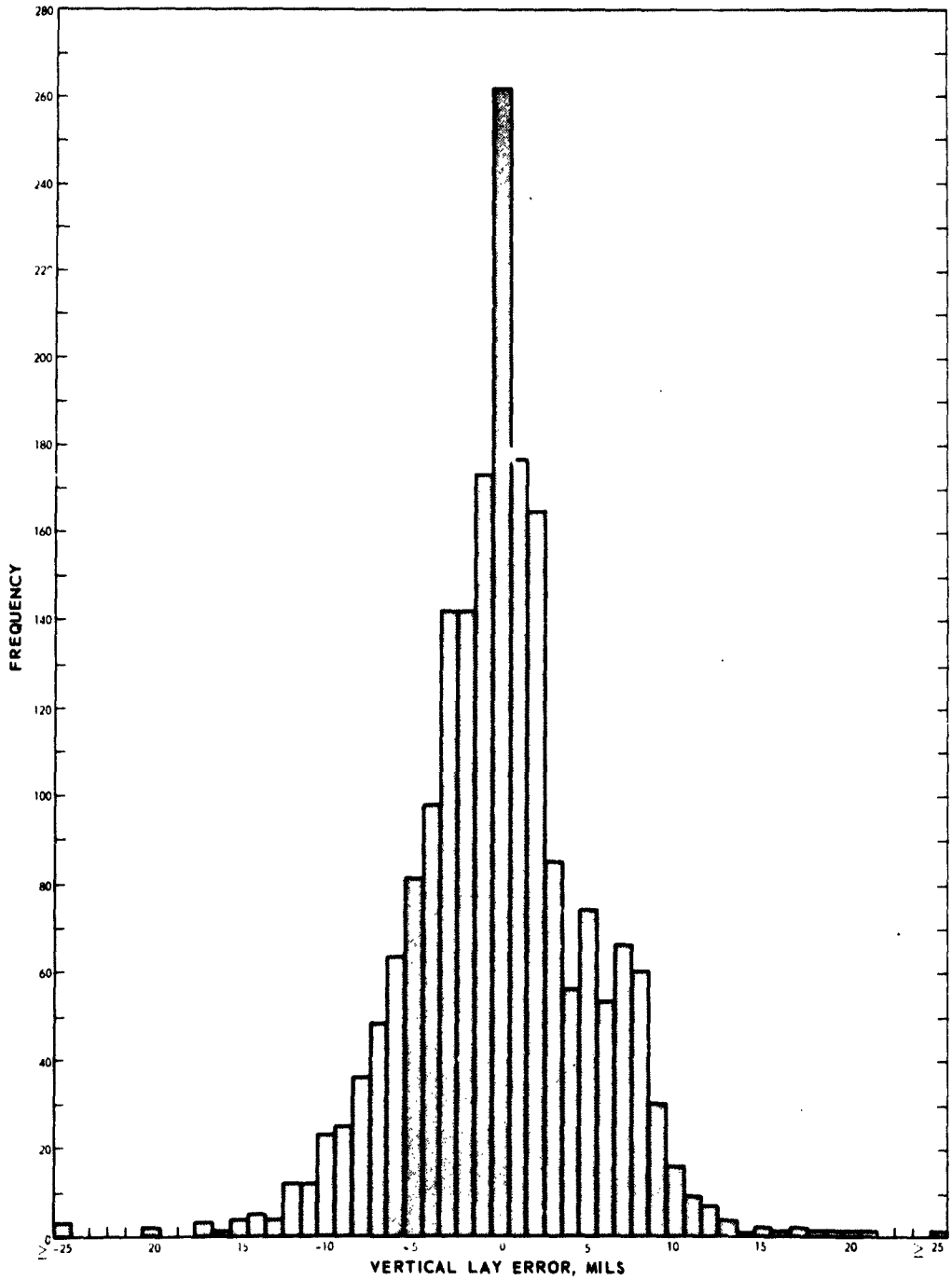


Fig. D6—Frequency Distribution of Vertical Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 550–750 m: n = 1951

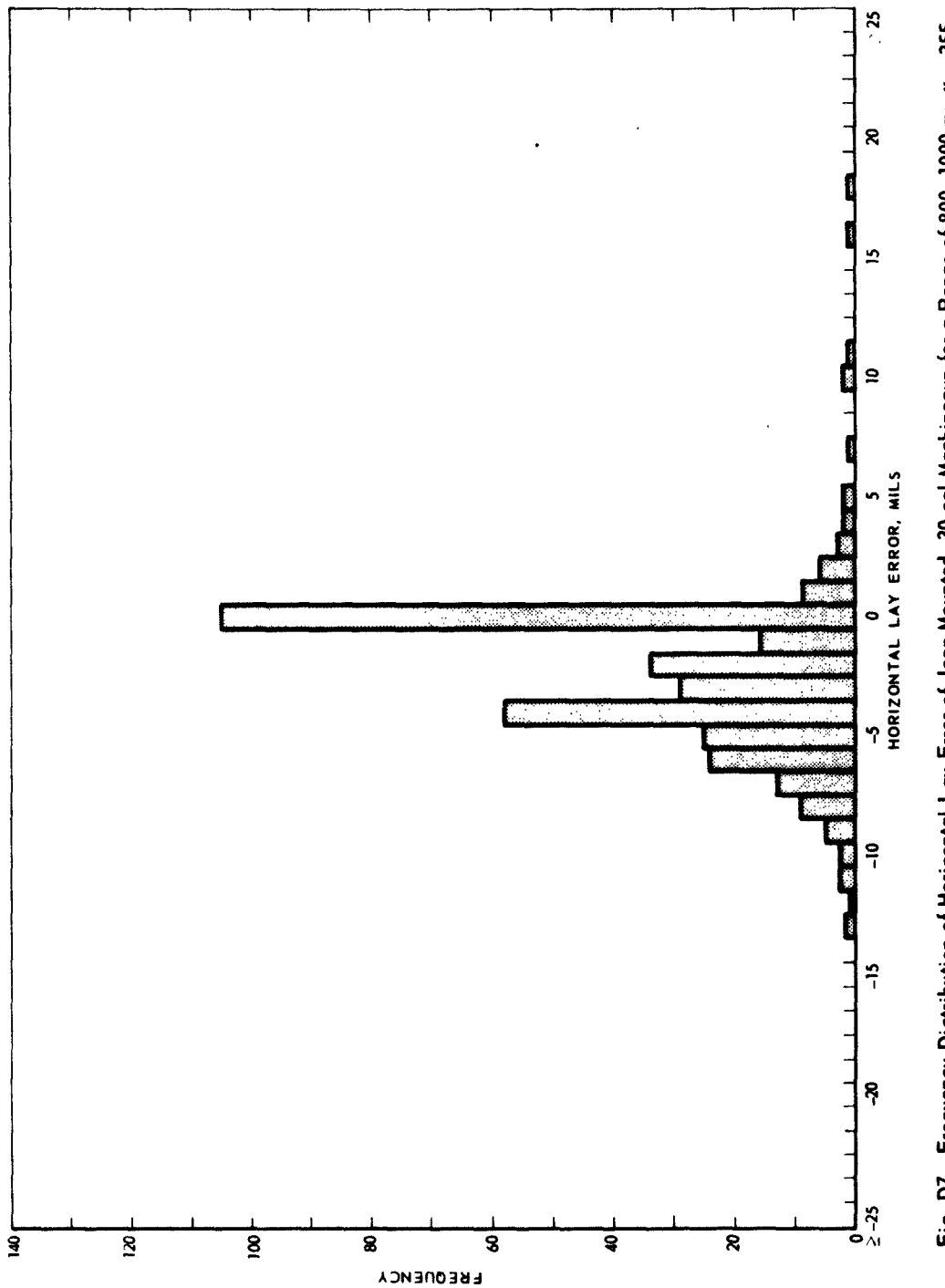


Fig. D7—Frequency Distribution of Horizontal Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 800–1000 m: n 355

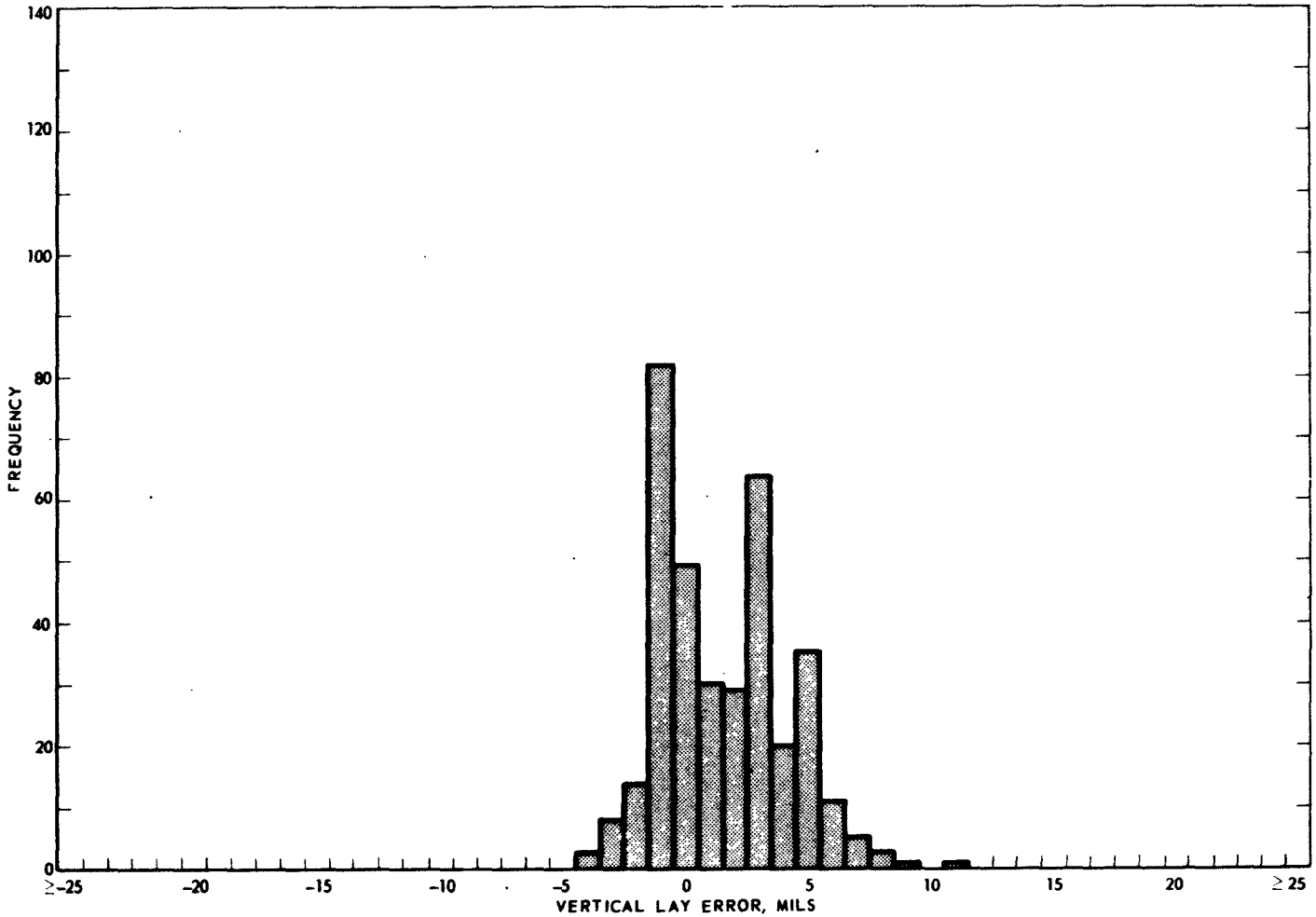


Fig. D8—Frequency Distribution of Vertical Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 800–1000 m: $n_t = 355$

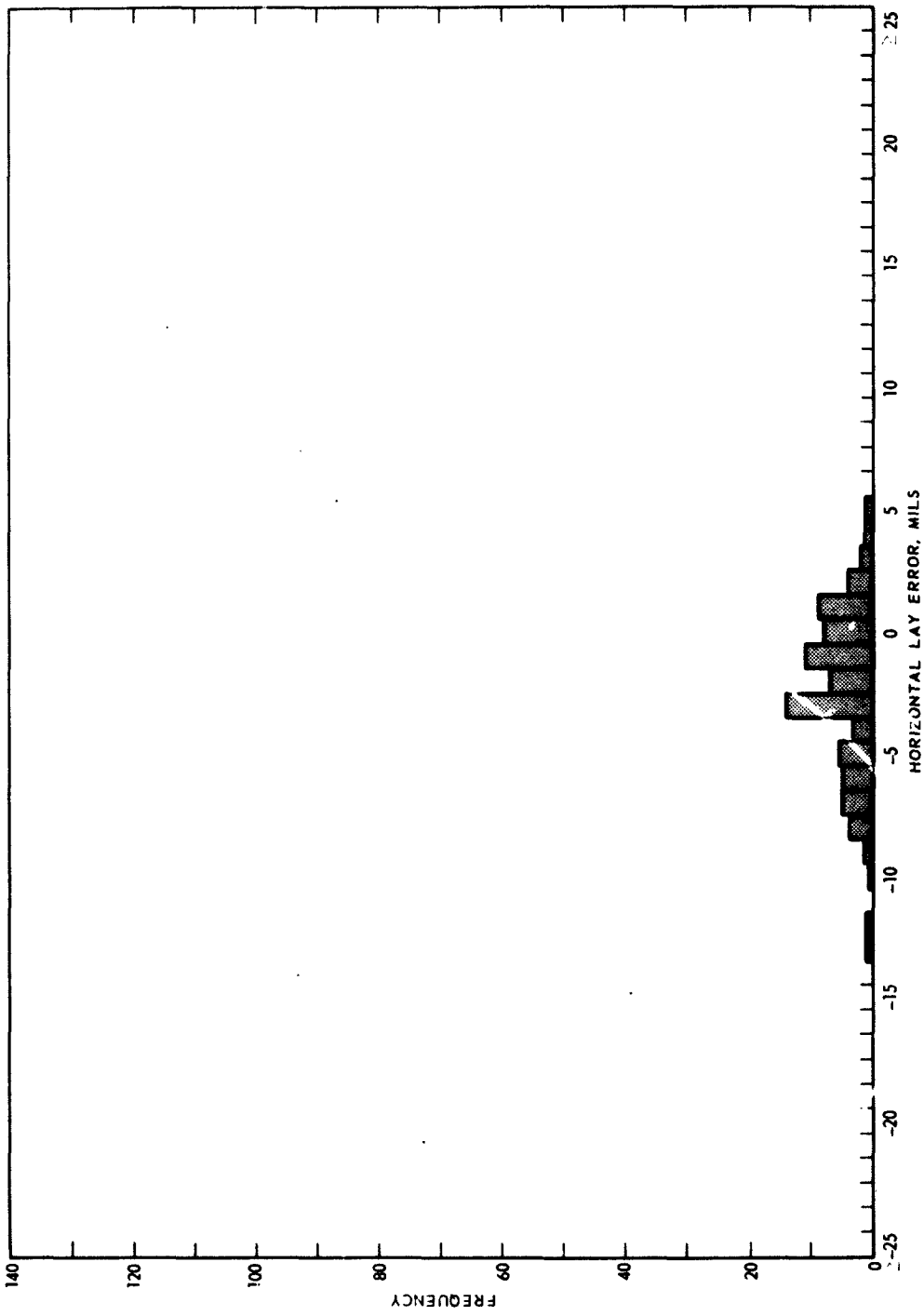


Fig. D9—Frequency Distribution of Horizontal Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 1050–1250 m: n = 81

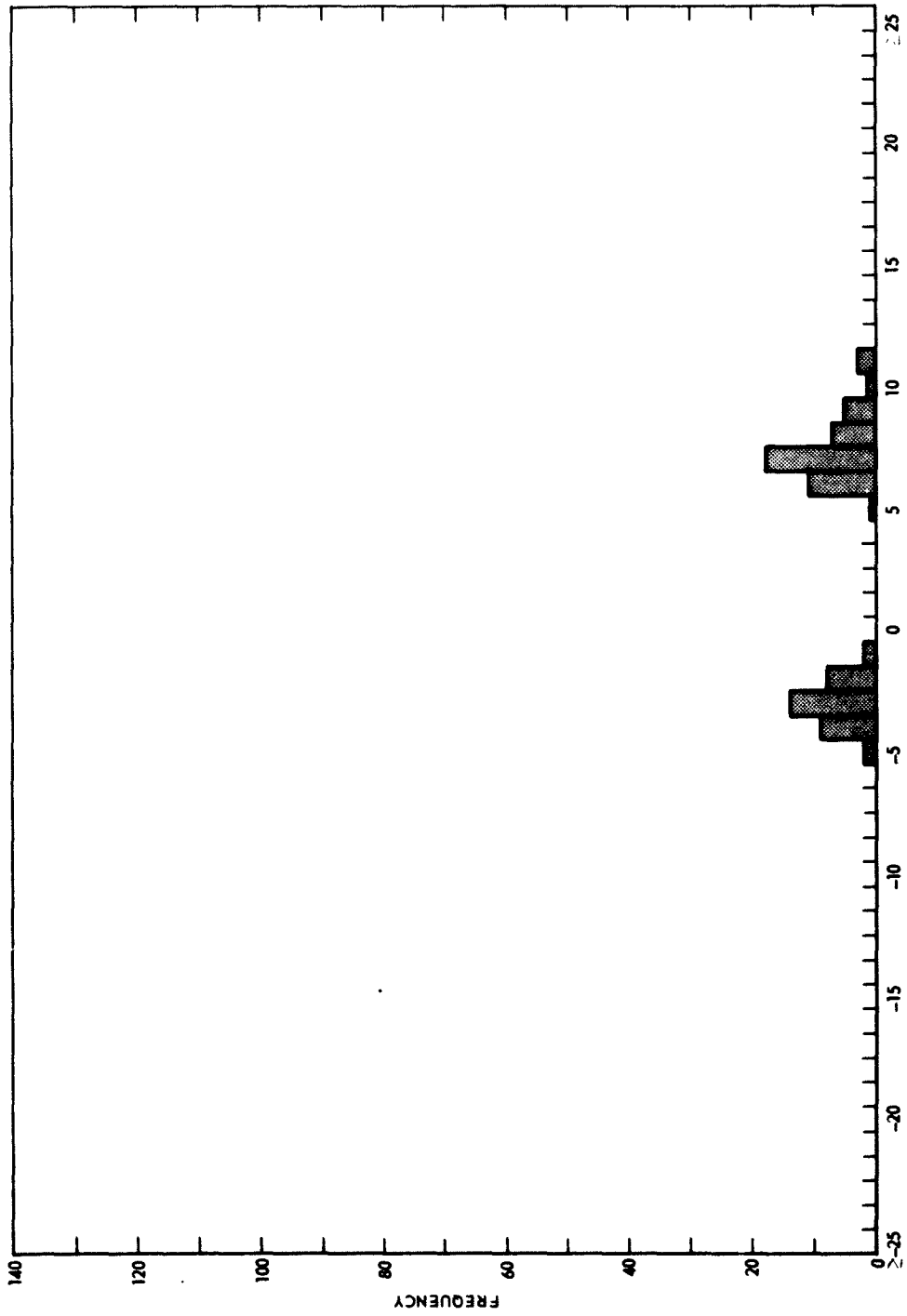


Fig. D10—Frequency Distribution of Vertical Lay Error of Jeep-Mounted .30-cal Machinegun for a Range of 1050–1250 m: $n = 81$

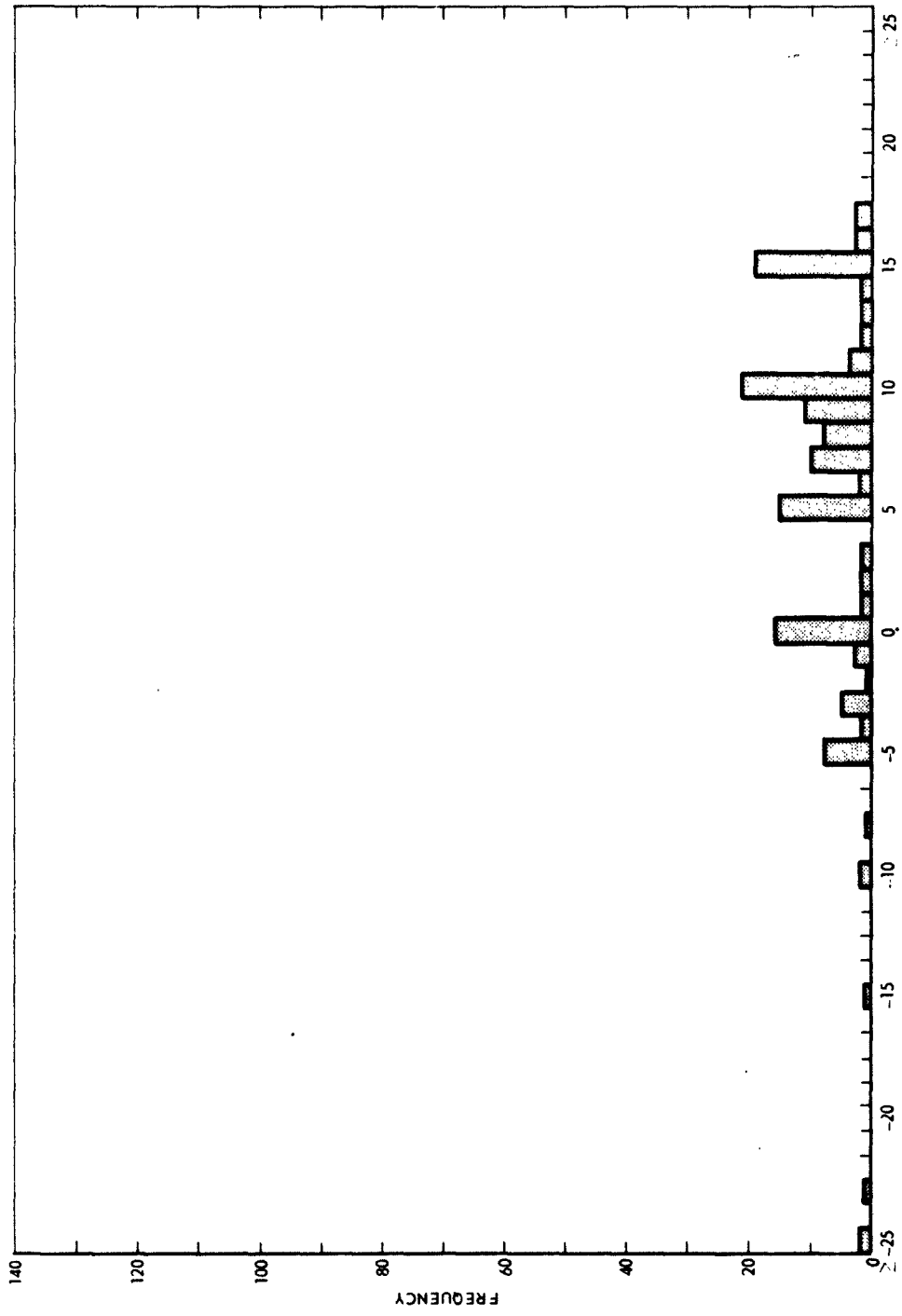


Fig. D11—Frequency Distribution of Horizontal Lay Error of Infantry-Fired .30-cal Machinegun for a Range of 0–250 m: n = 150

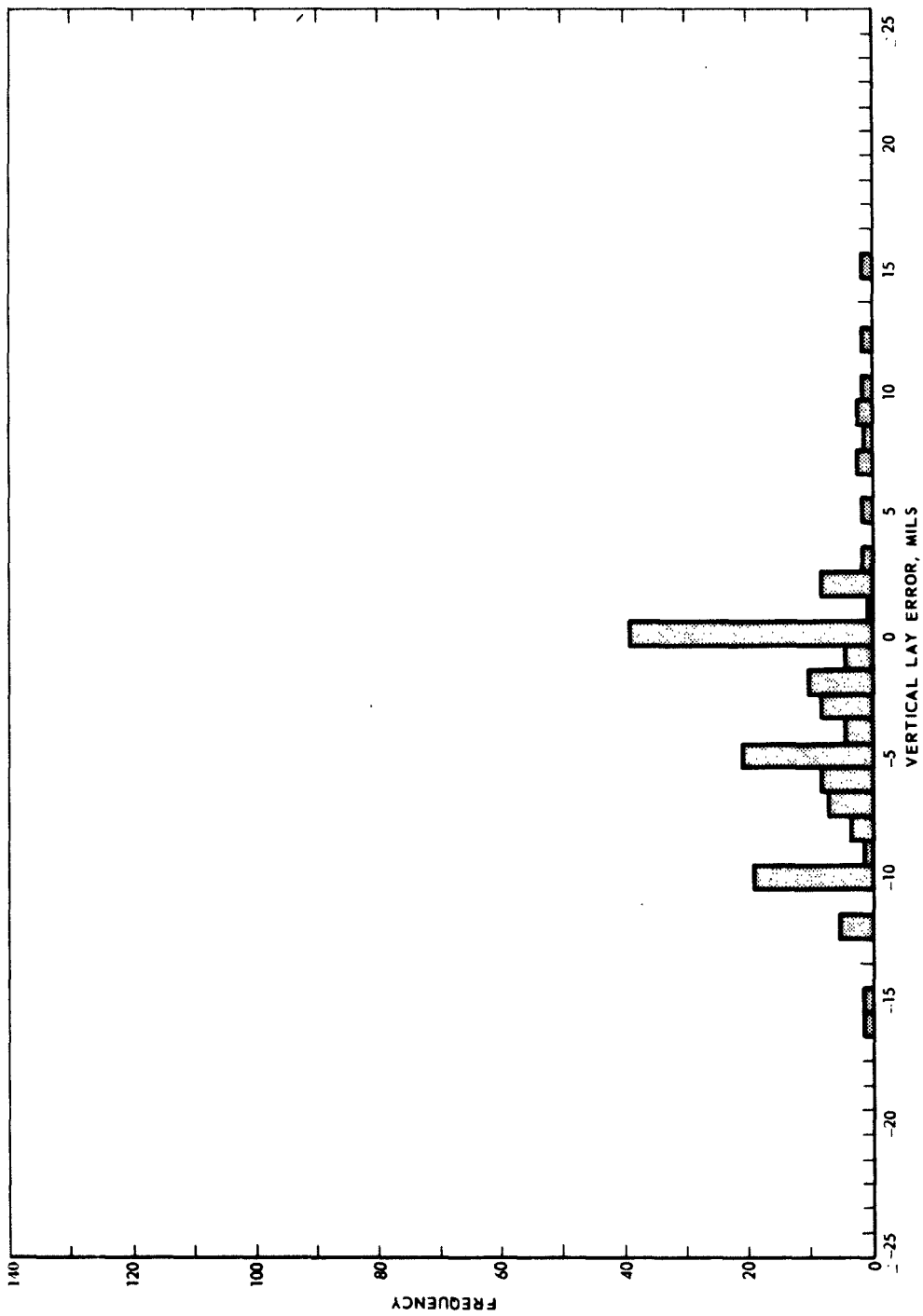


Fig. D12—Frequency Distribution of Vertical Lay Error of Infantry-Fired .30-cal Machinegun for a Range of 0–250 m: n = 150

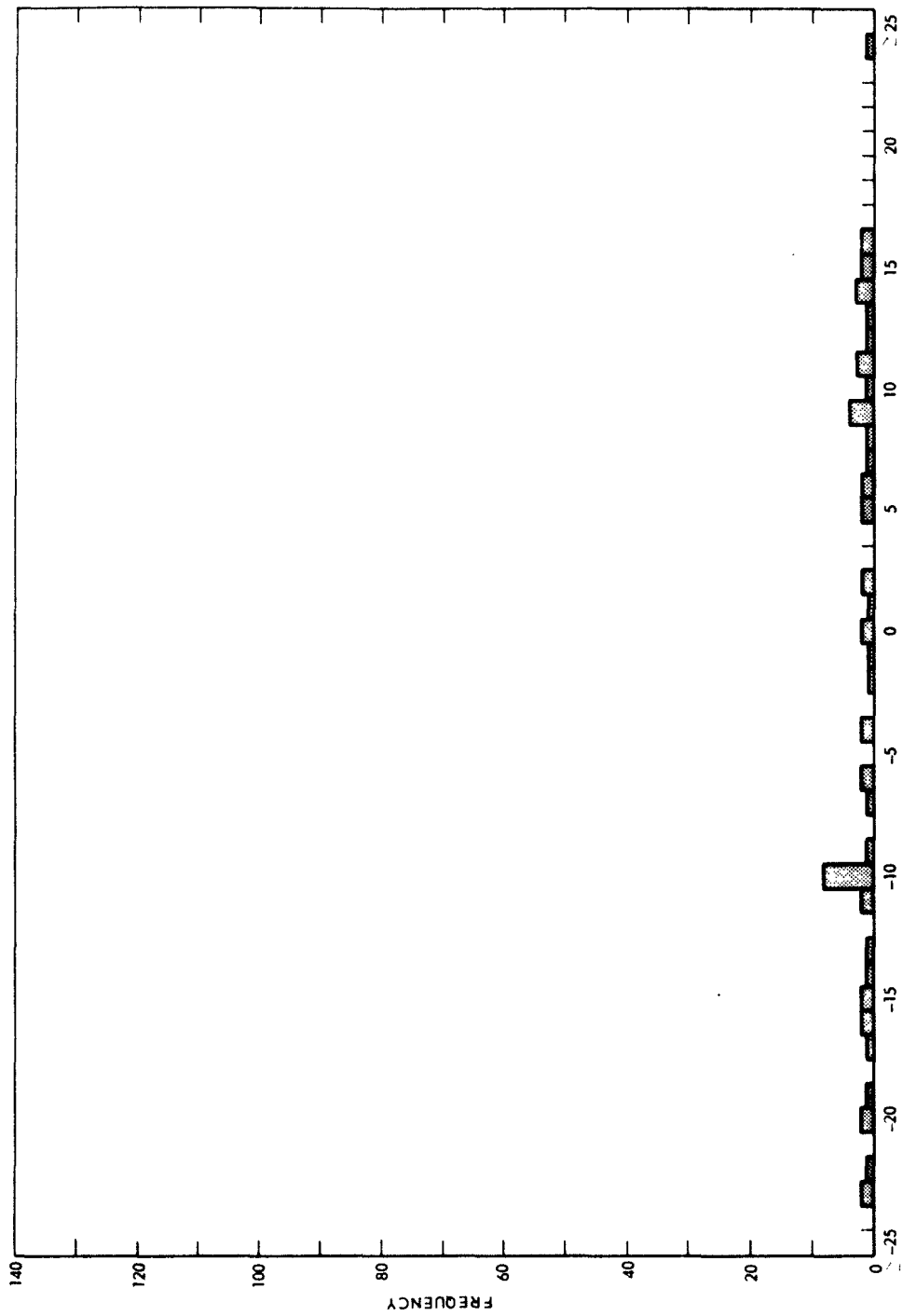


Fig. D13—Frequency Distribution of Horizontal Lay Error of Infantry-Fired .30-cal Machinegun for a Range of 300–500 m: n = 58

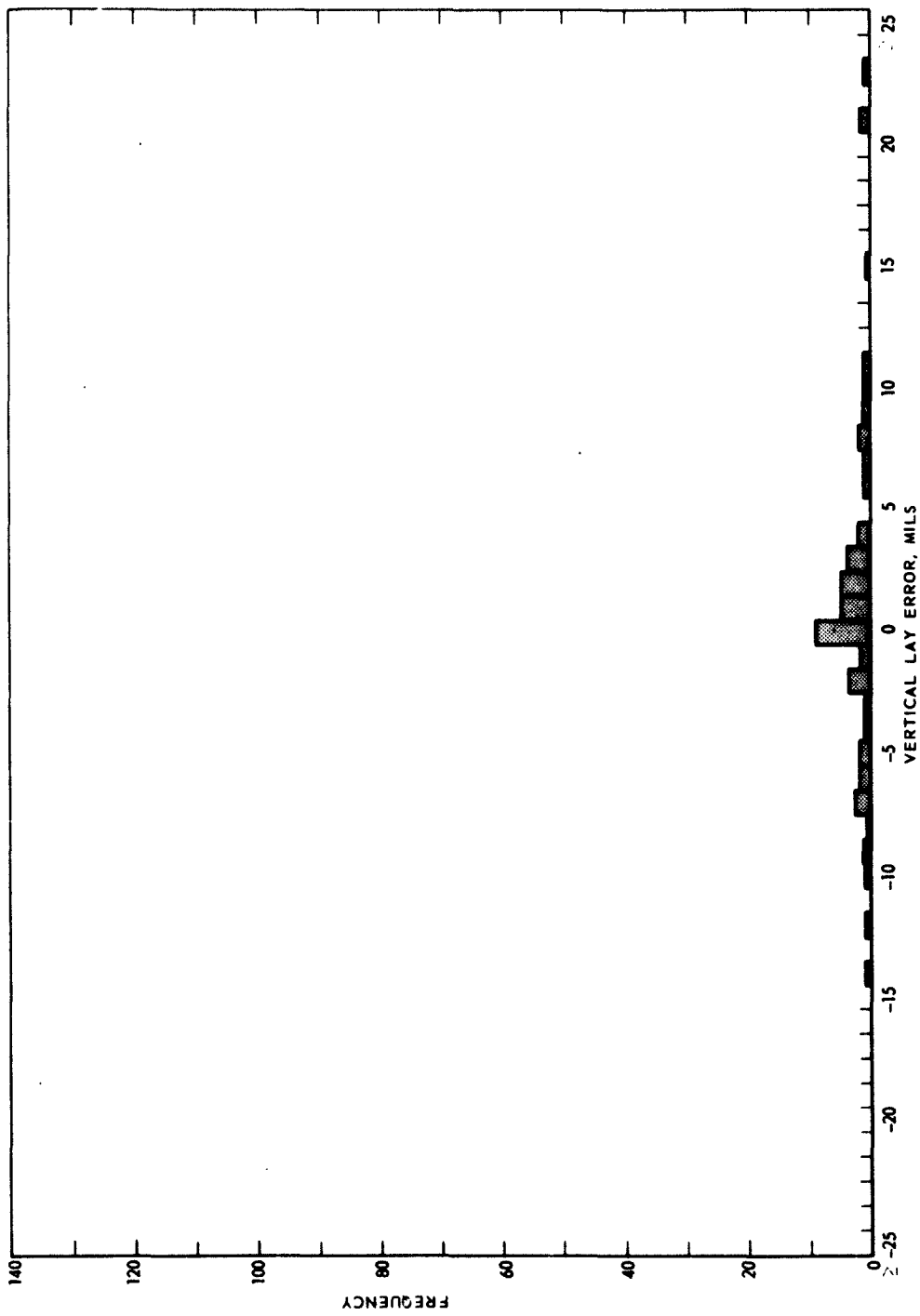


Fig. D14—Frequency Distribution of Vertical Lay Error of Infantry-Fired .30-cal Machinegun for a Range of 300–500 m: $n = 58$

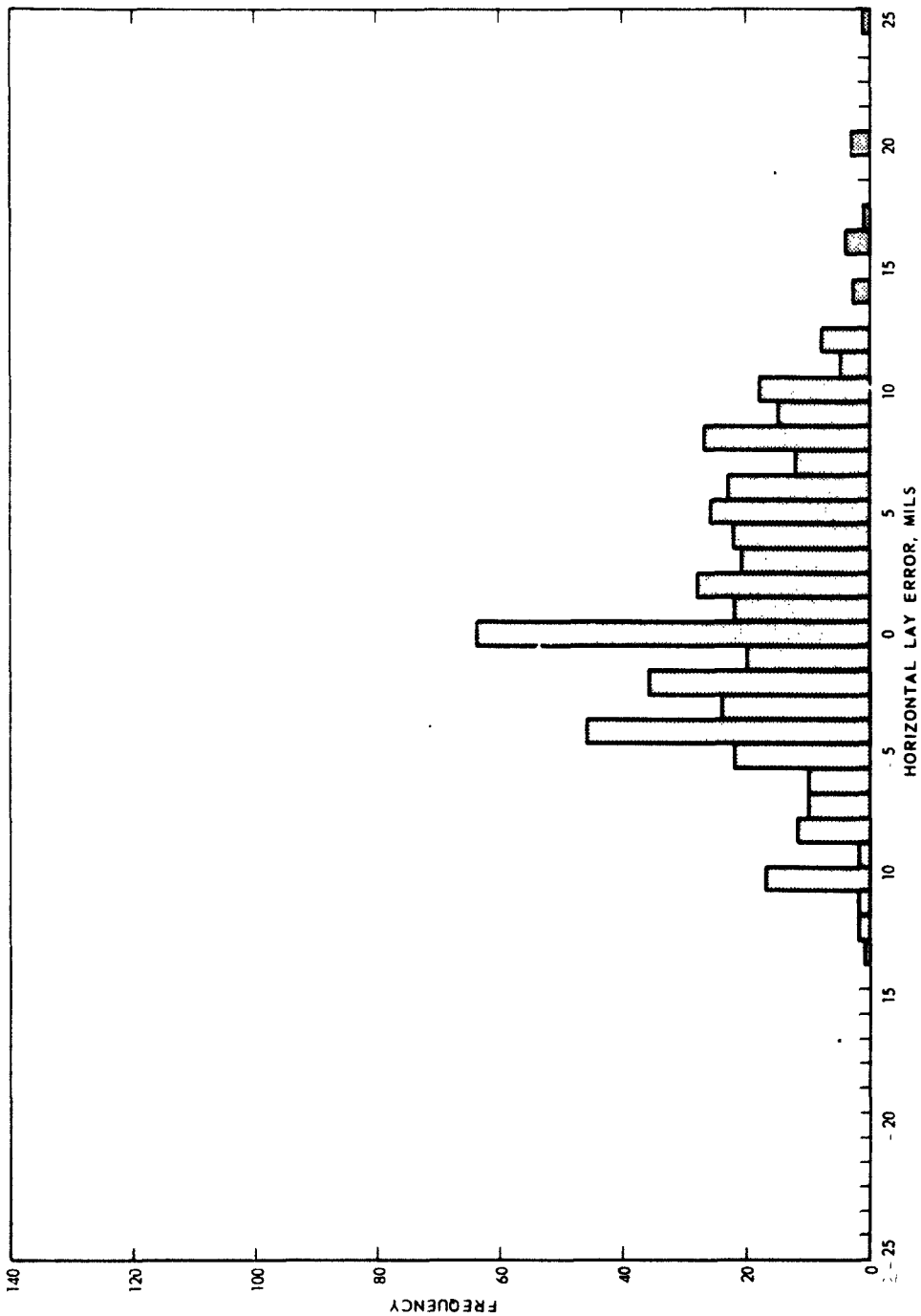


Fig. D15—Frequency Distribution of Horizontal Lay Error of Infantry-Fired .30-cal Machinegun for a Range of 550–750 m: n = 512

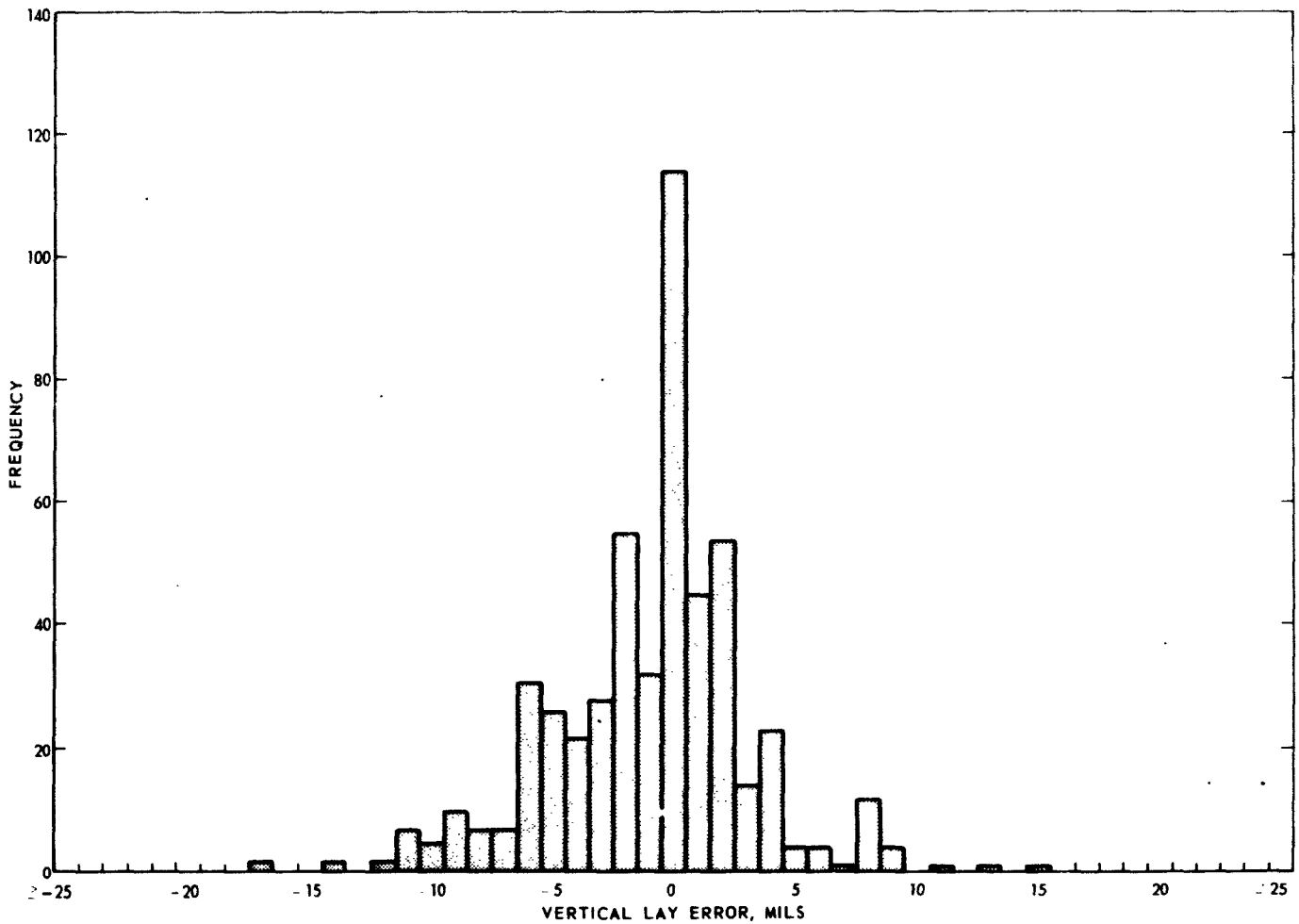


Fig. D16—Frequency Distribution of Vertical Lay Error of Infantry-Fired .30-cal Machinegun for a Range of 550–750 m: $n = 512$

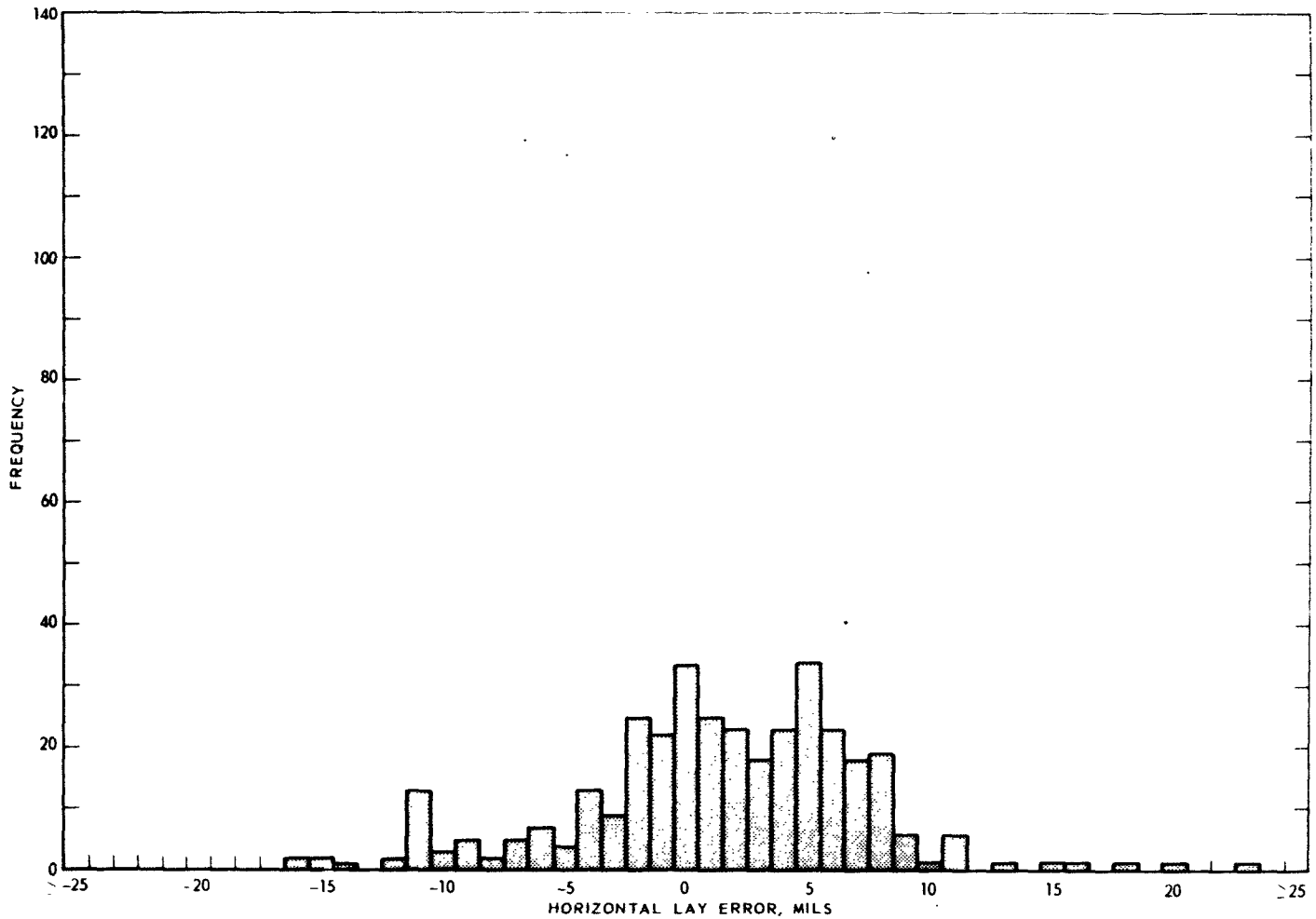


Fig. D17—Frequency Distribution of Horizontal Lay Error of Infantry-Fired .30-cal Machinegun for a Range of 800–1000 m: n = 314

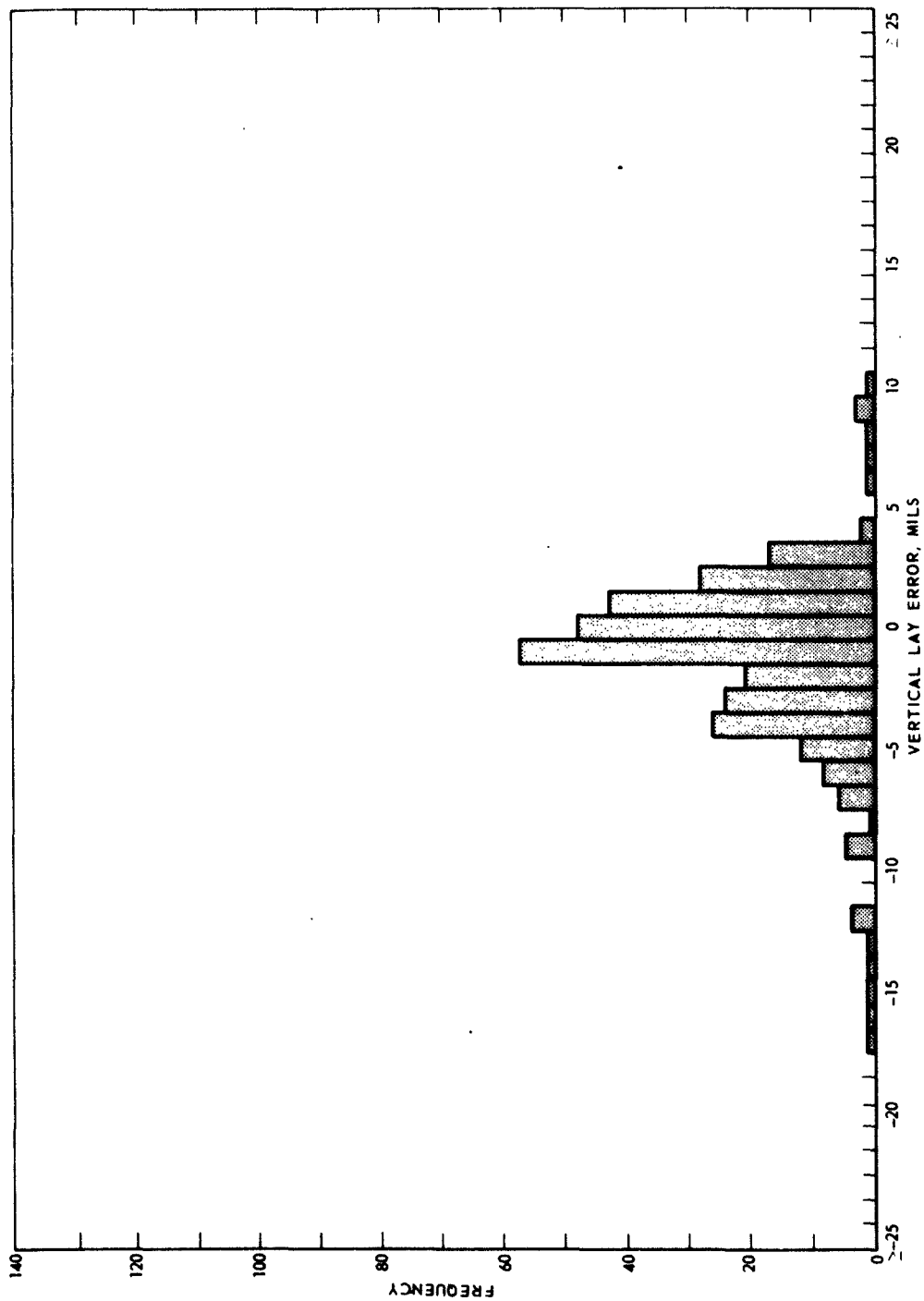


Fig. D18—Frequency Distribution of Vertical Lay Error of Infantry-Fired .30-cal Machinegun for a Range of 800–1000 m: n = 314

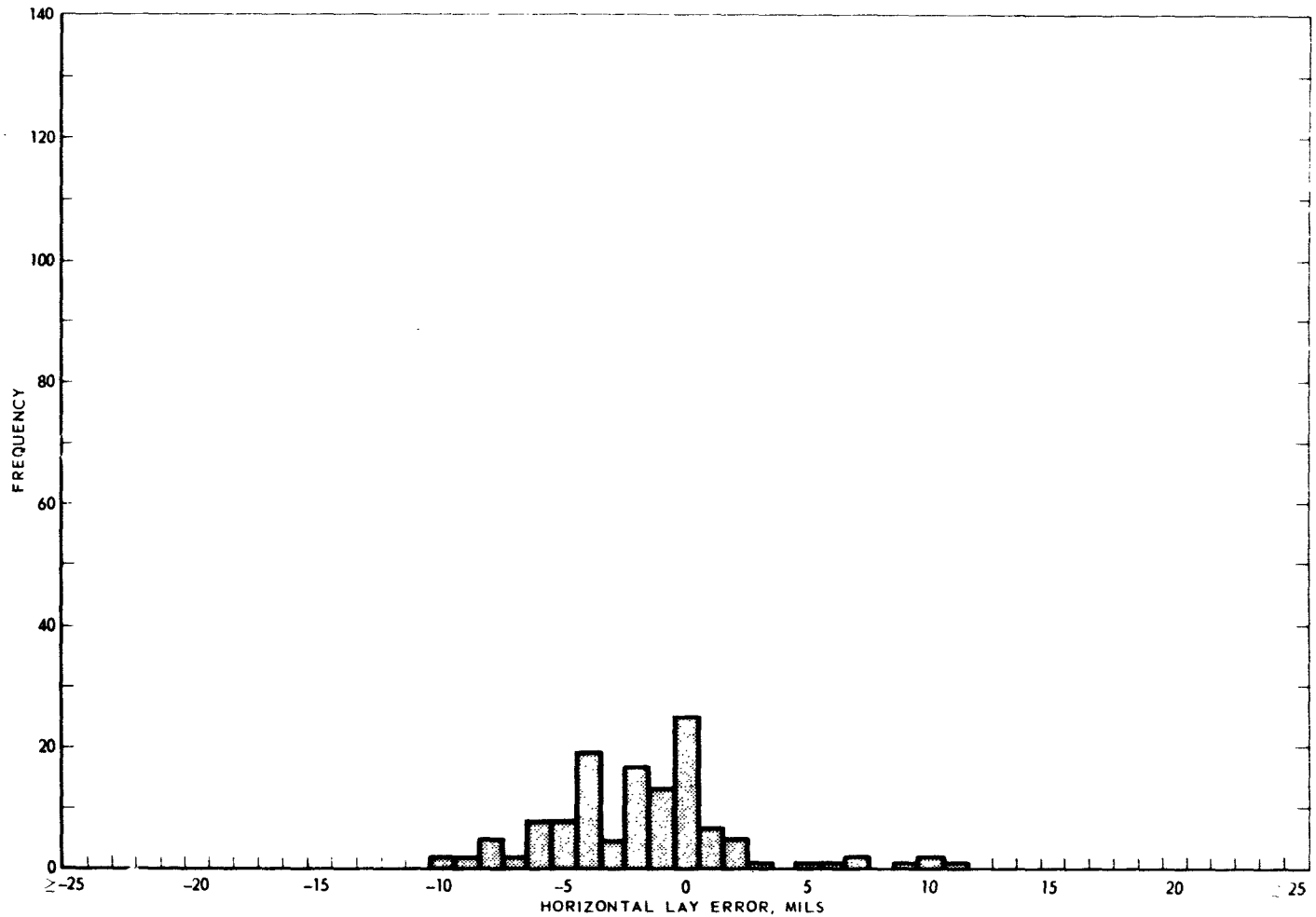


Fig. D19—Frequency Distribution of Horizontal Lay Error of Tank-Mounted .50-cal Machinegun for a Range of 550–750 m: $n = 127$

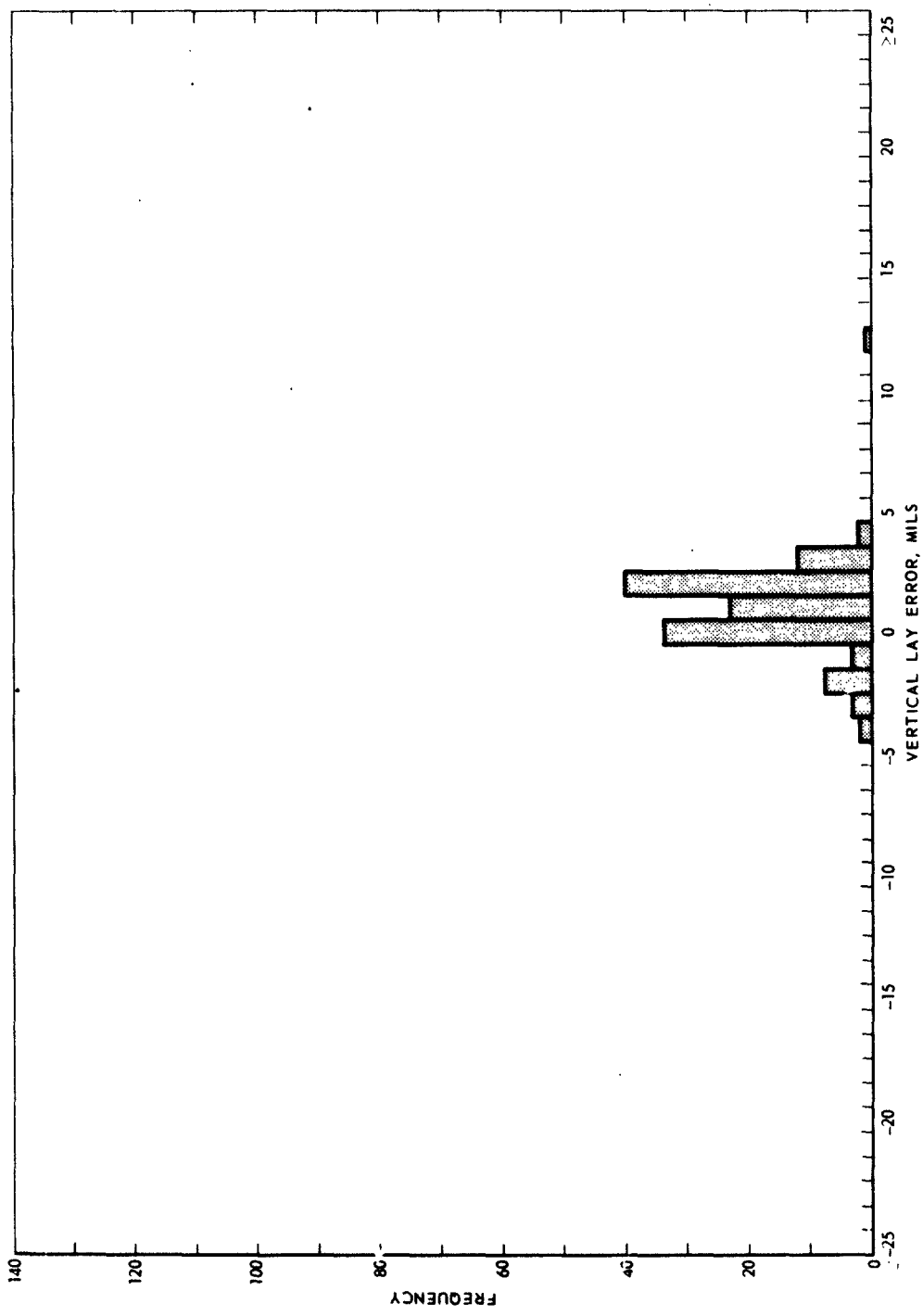


Fig. D20—Frequency Distribution of Vertical Lay Error of Tank-Mounted .50-cal Machinegun for a Range of 550–750 m: n = 127

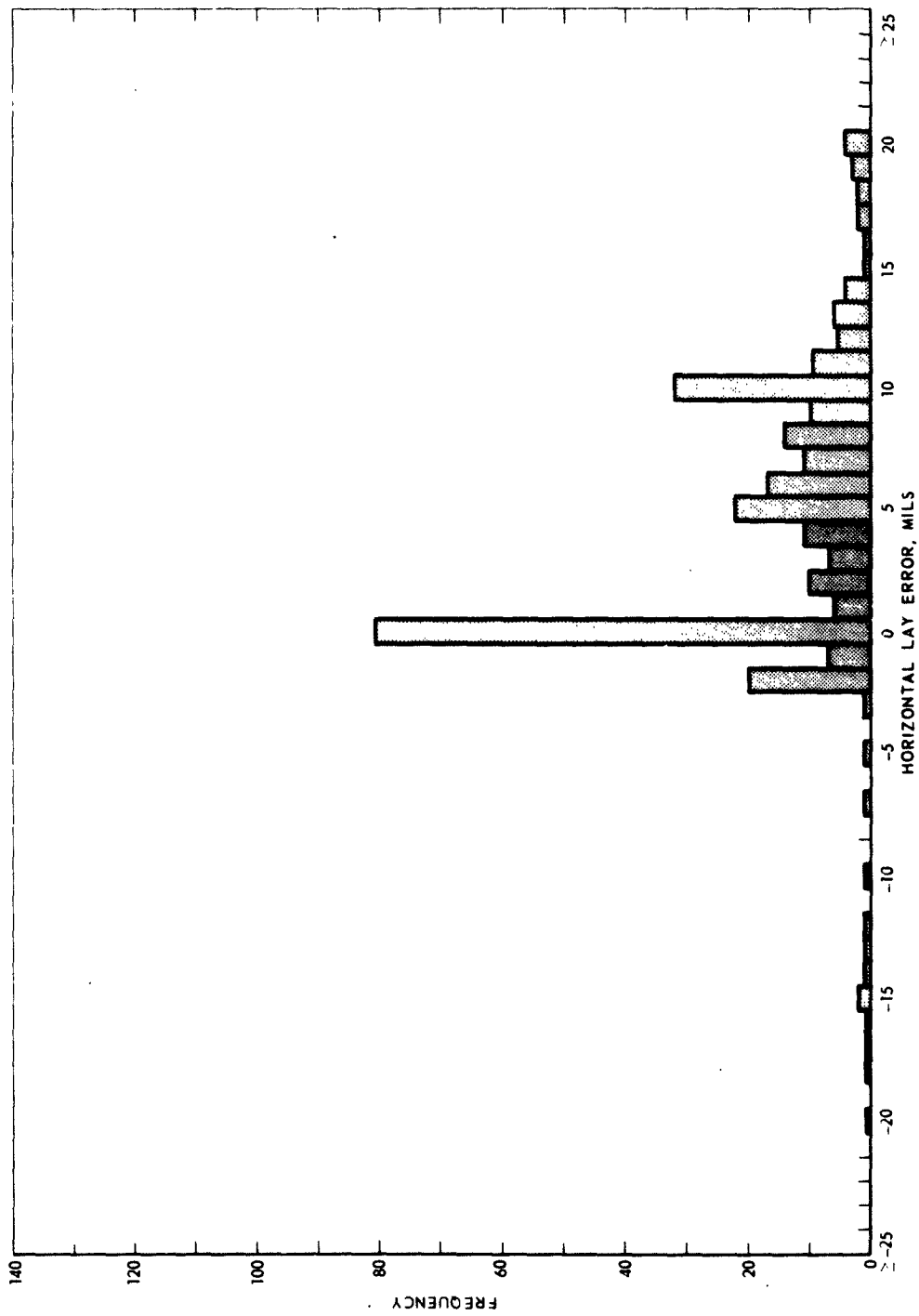


Fig. D21—Frequency Distribution of Horizontal Lay Error of Tank-Mounted .50-cal Machinegun for a Range of 800–1000 m: n = 298

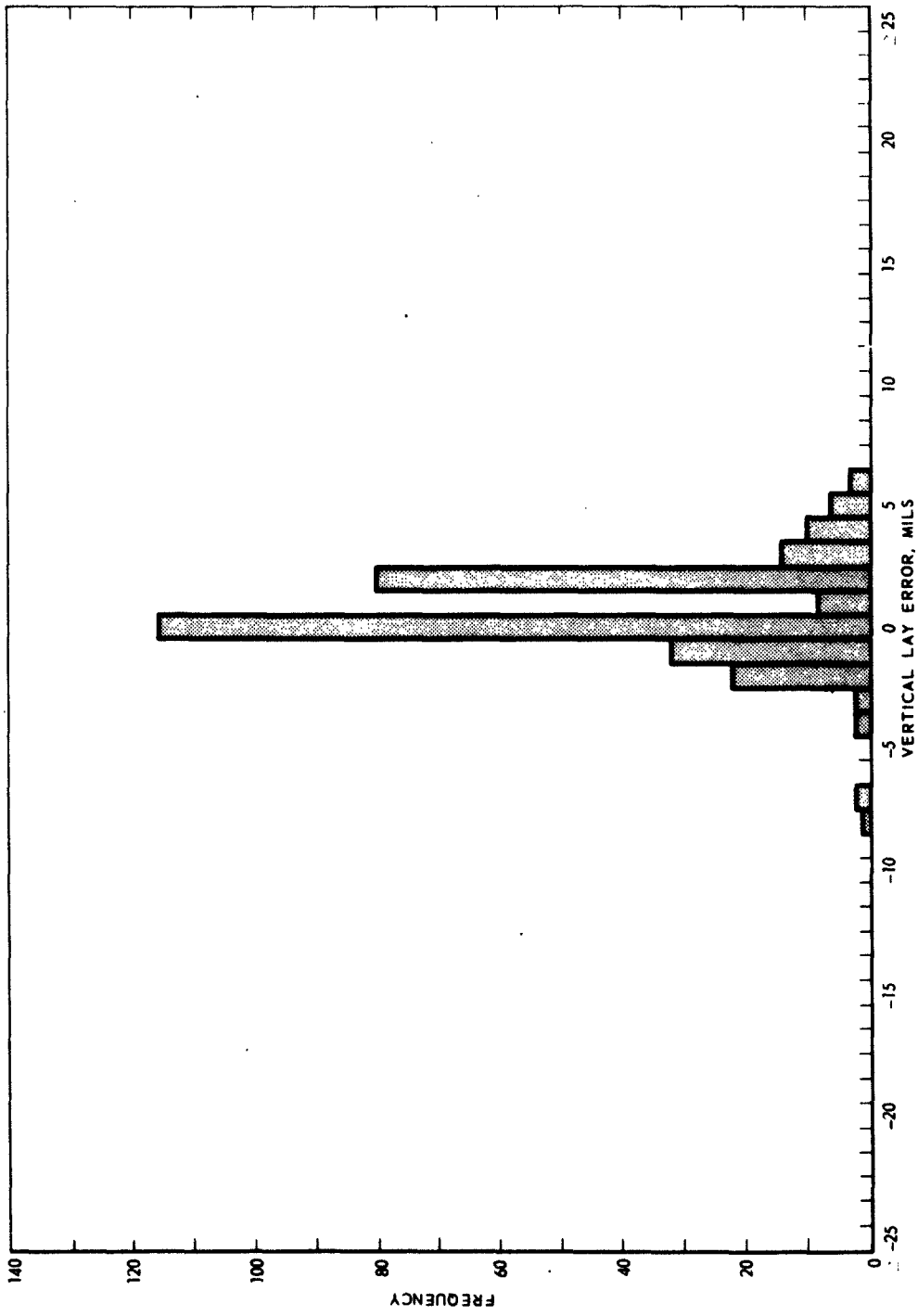


Fig. D22—Frequency Distribution of Vertical Lay Error of Tank-Mounted .50-cal Machinegun for a Range of 800–1000 m: n = 298

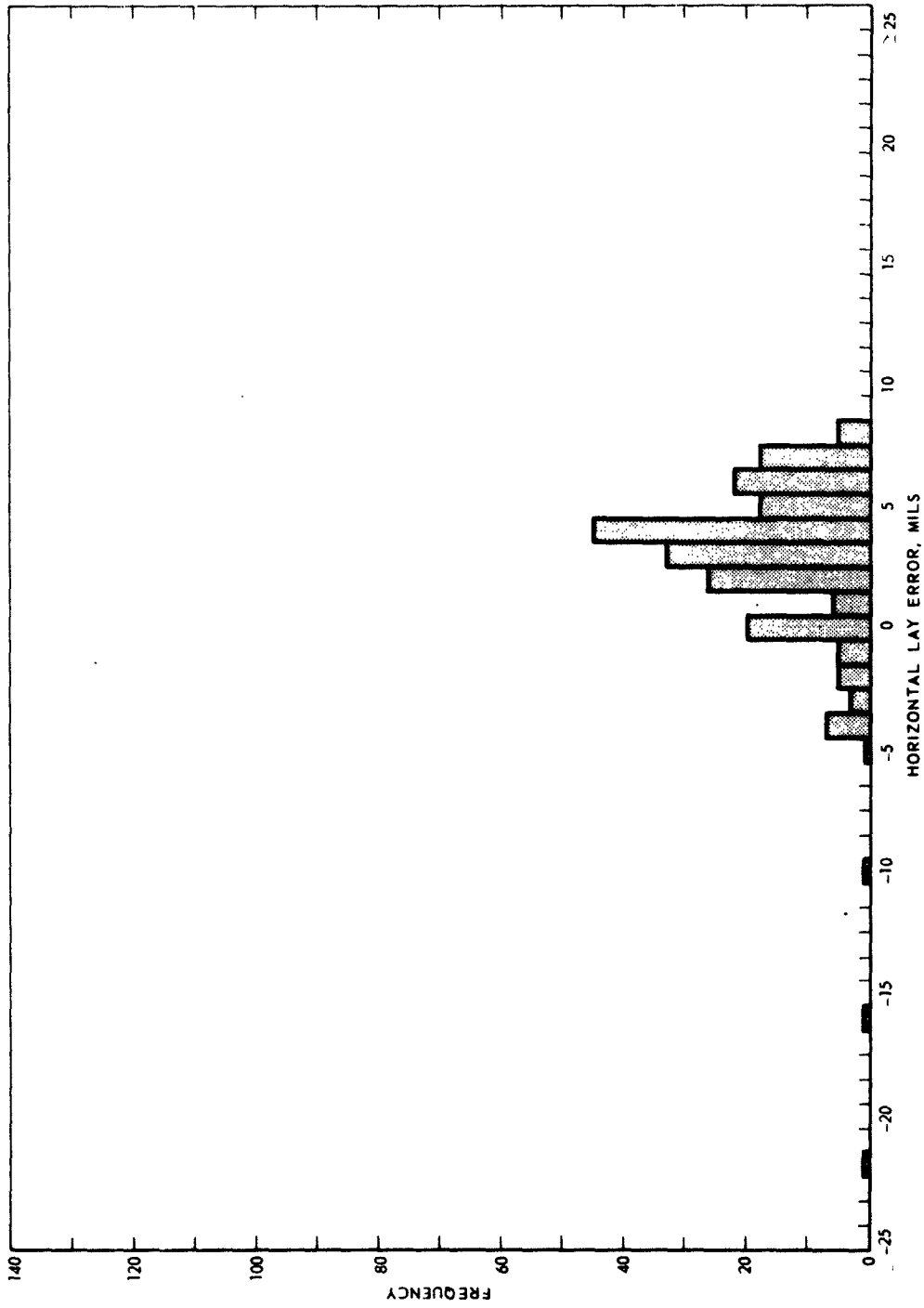


Fig. D23—Frequency Distribution of Horizontal Lay Error of Tank-Mounted .50-cal Machinegun for a Range of 1050–1250 m: n = 217

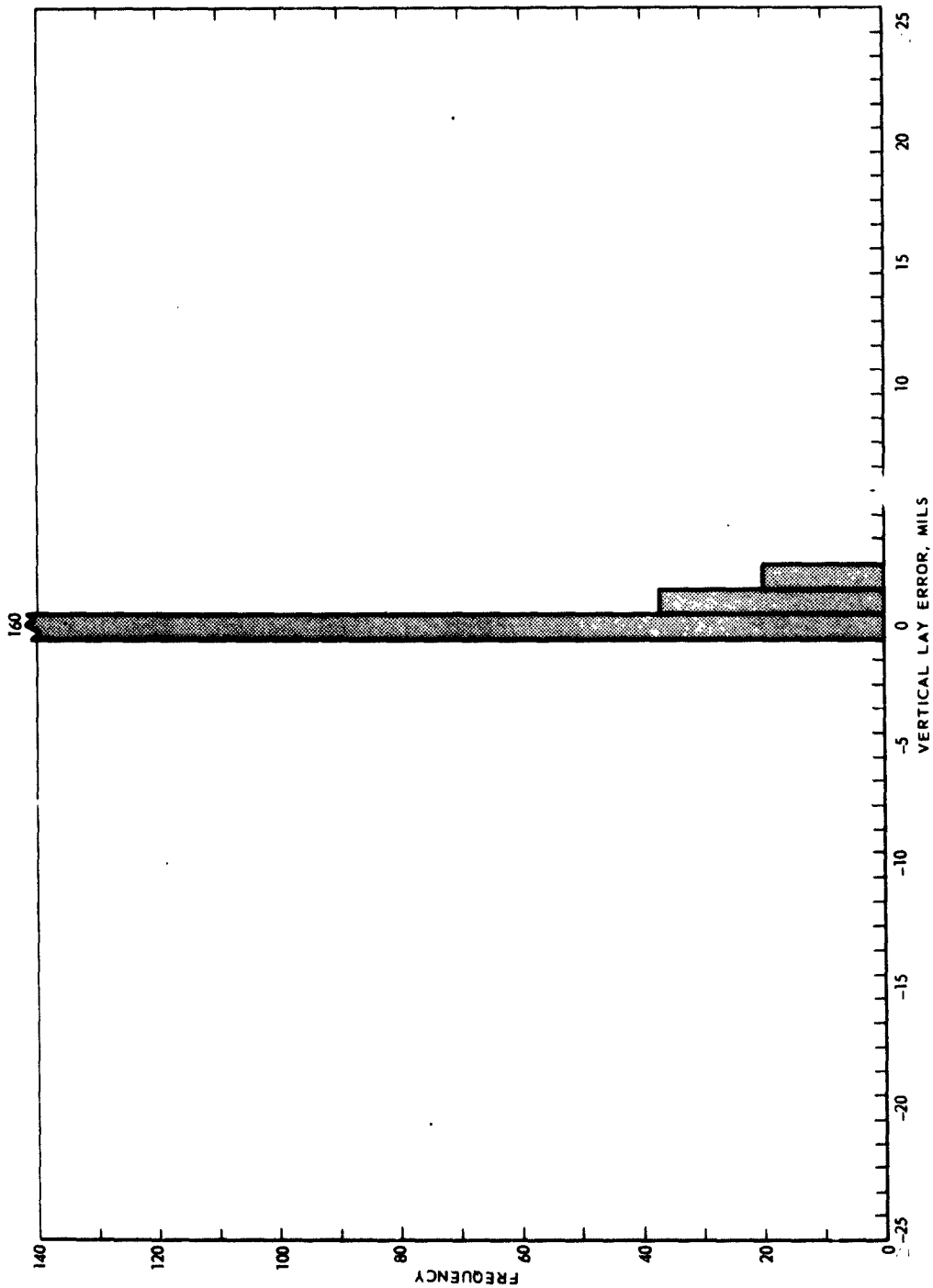


Fig. D24—Frequency Distribution of Vertical Lay Error of Tank-Mounted .50-cal Machinegun for a Range of 1050–1250 m: n = 217

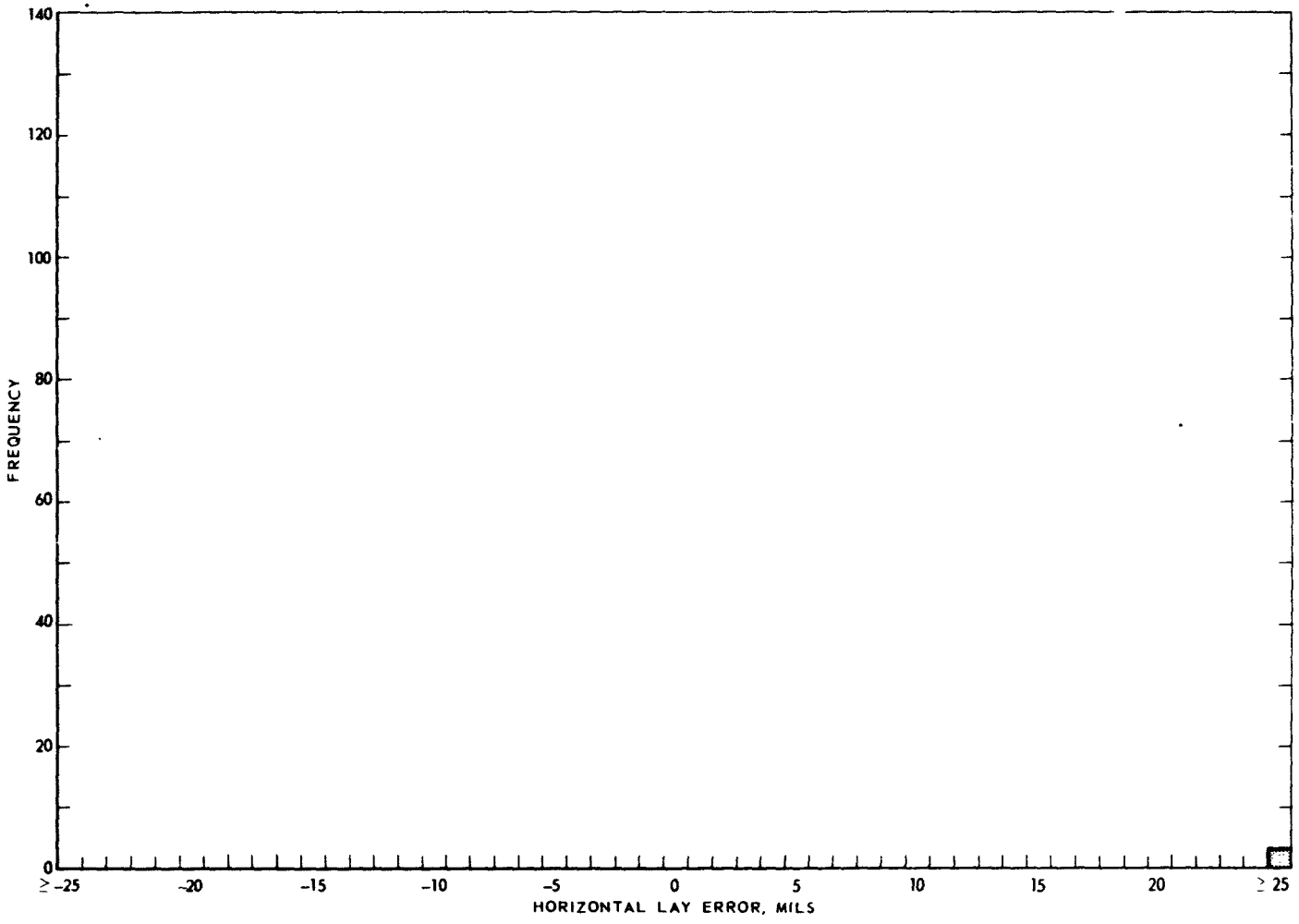


Fig. D25—Frequency Distribution of Horizontal Lay Error of APC-Mounted .50-cal Machinegun for a Range of 0–250 m: $n = 3$

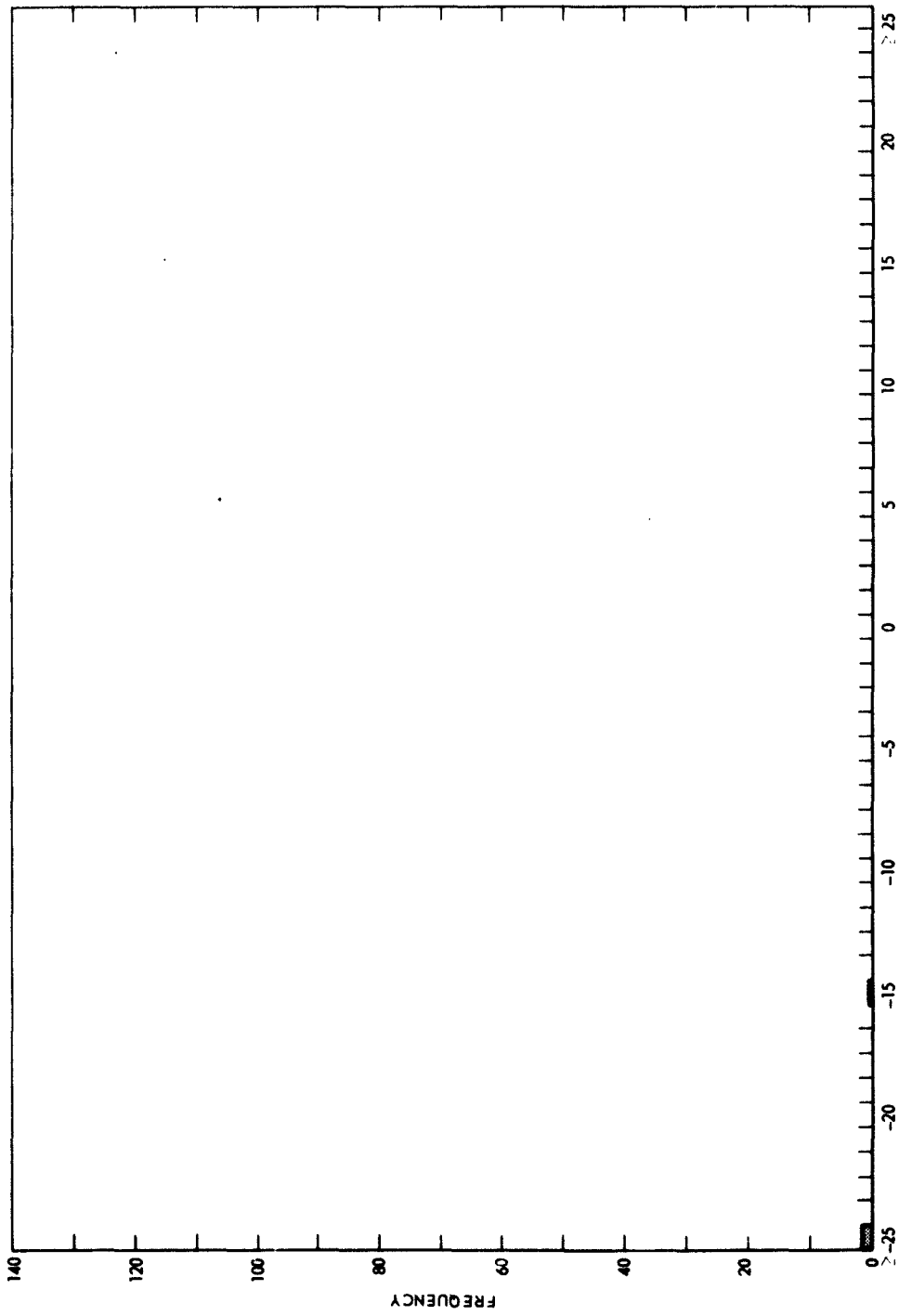


Fig. D26—Frequency Distribution of Vertical Lay Error of APC-Mounted .50-cal Machinegun for a Range of 0–250 m: n = 3

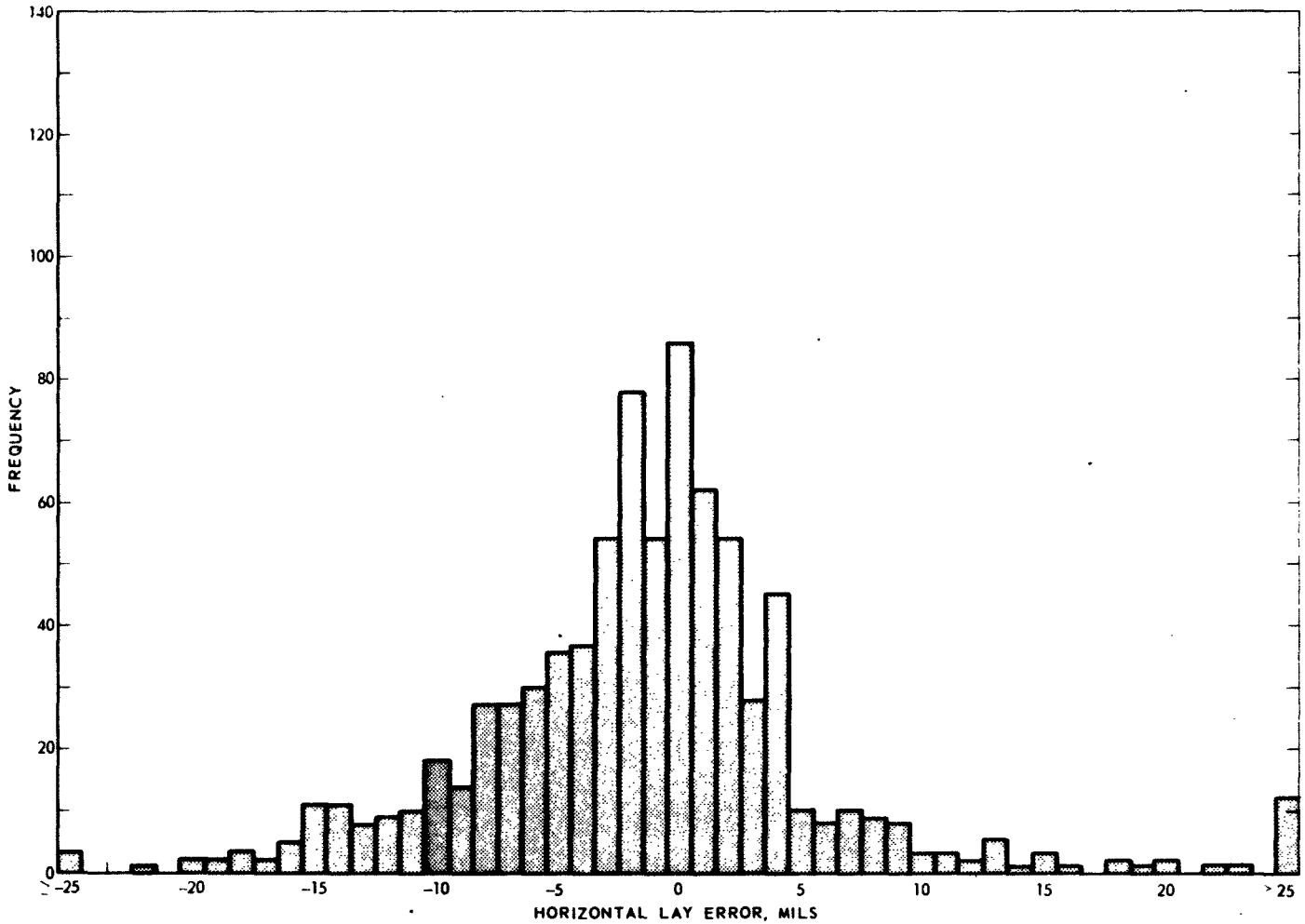


Fig. D27—Frequency Distribution of Horizontal Lay Error of APC-Mounted .50-cal Machinegun for a Range of 550–750 m: n = 780

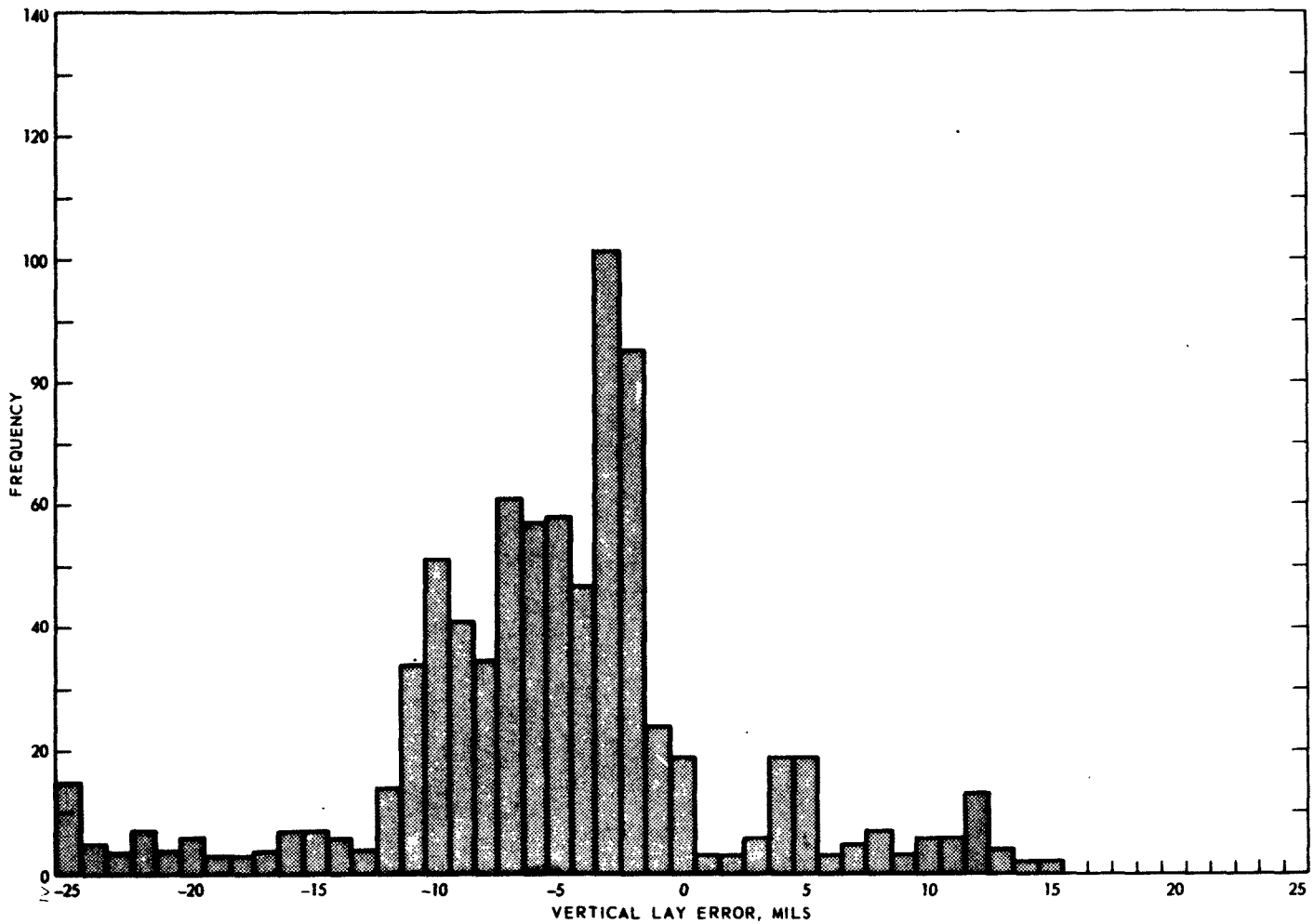


Fig. D28—Frequency Distribution of Vertical Lay Error of APC-Mounted .50-cal Machinegun for a Range of 550–750 m: $n = 780$

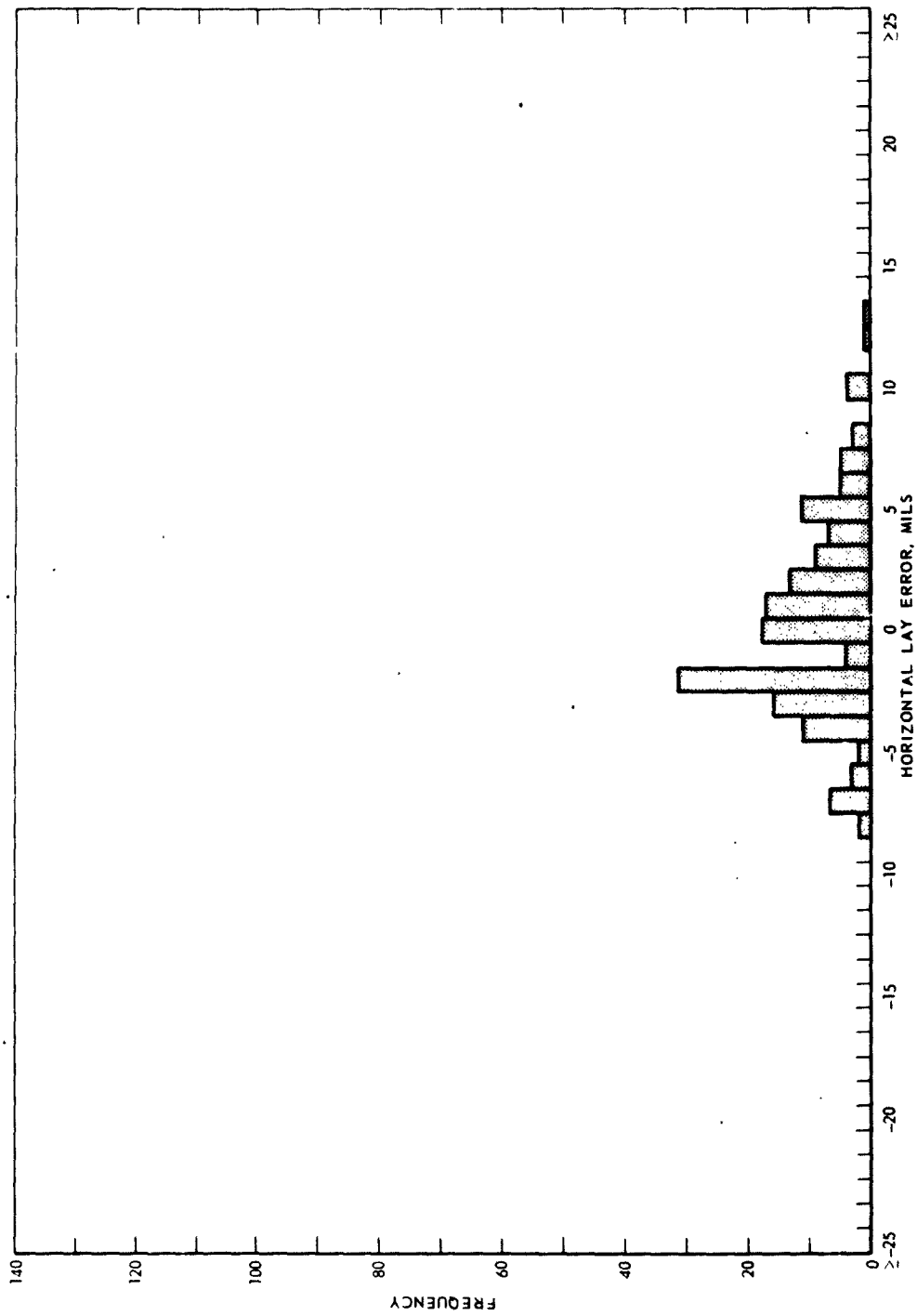


Fig. D29—Frequency Distribution of Horizontal Lay Error of APC-Mounted .50-cal Machinegun for a Range of 800–1000 m: n = 170

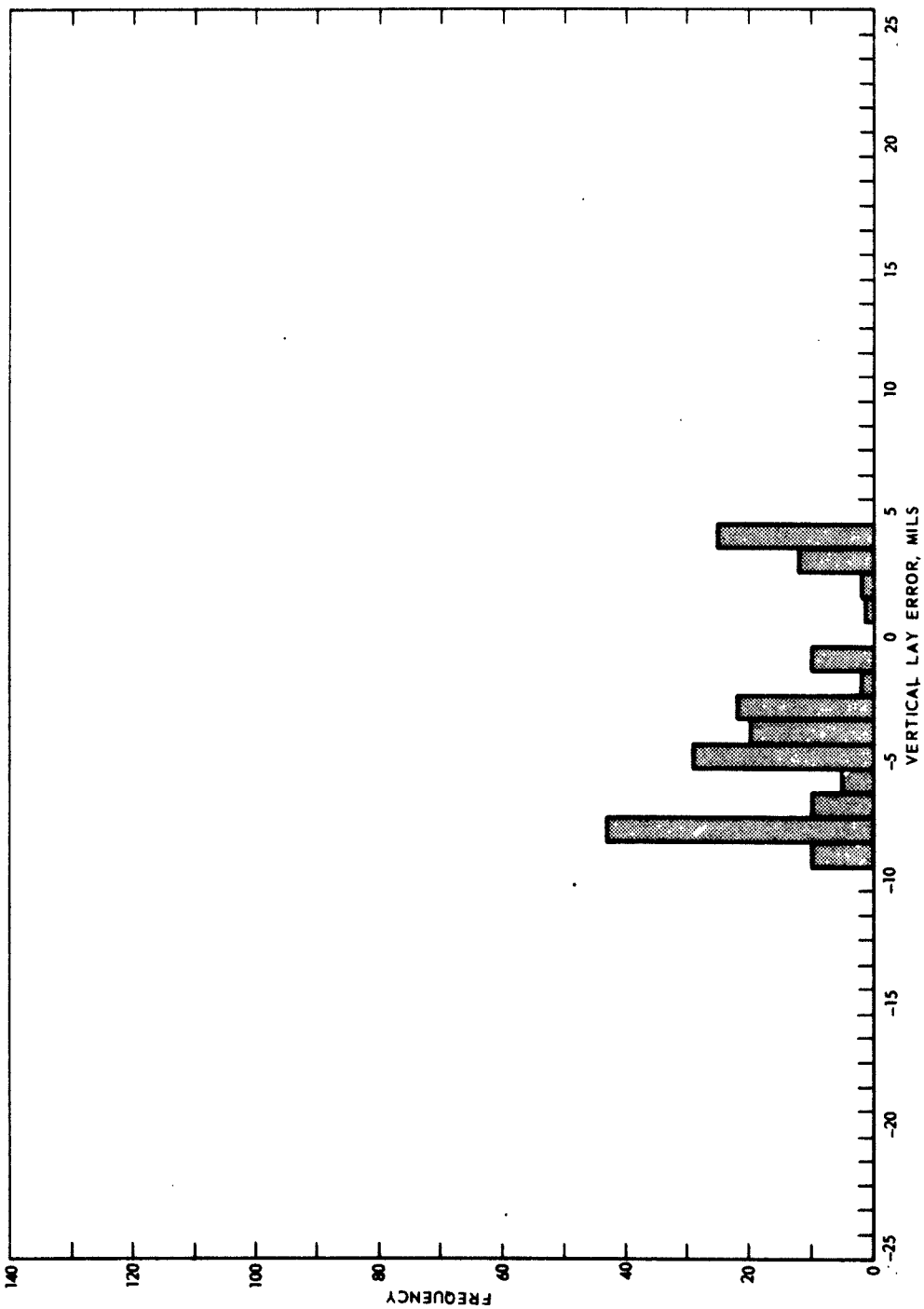


Fig. D30—Frequency Distribution of Vertical Lay Error of APC-Mounted .50-cal Machinegun for a Range of 800–1000 m: n = 170

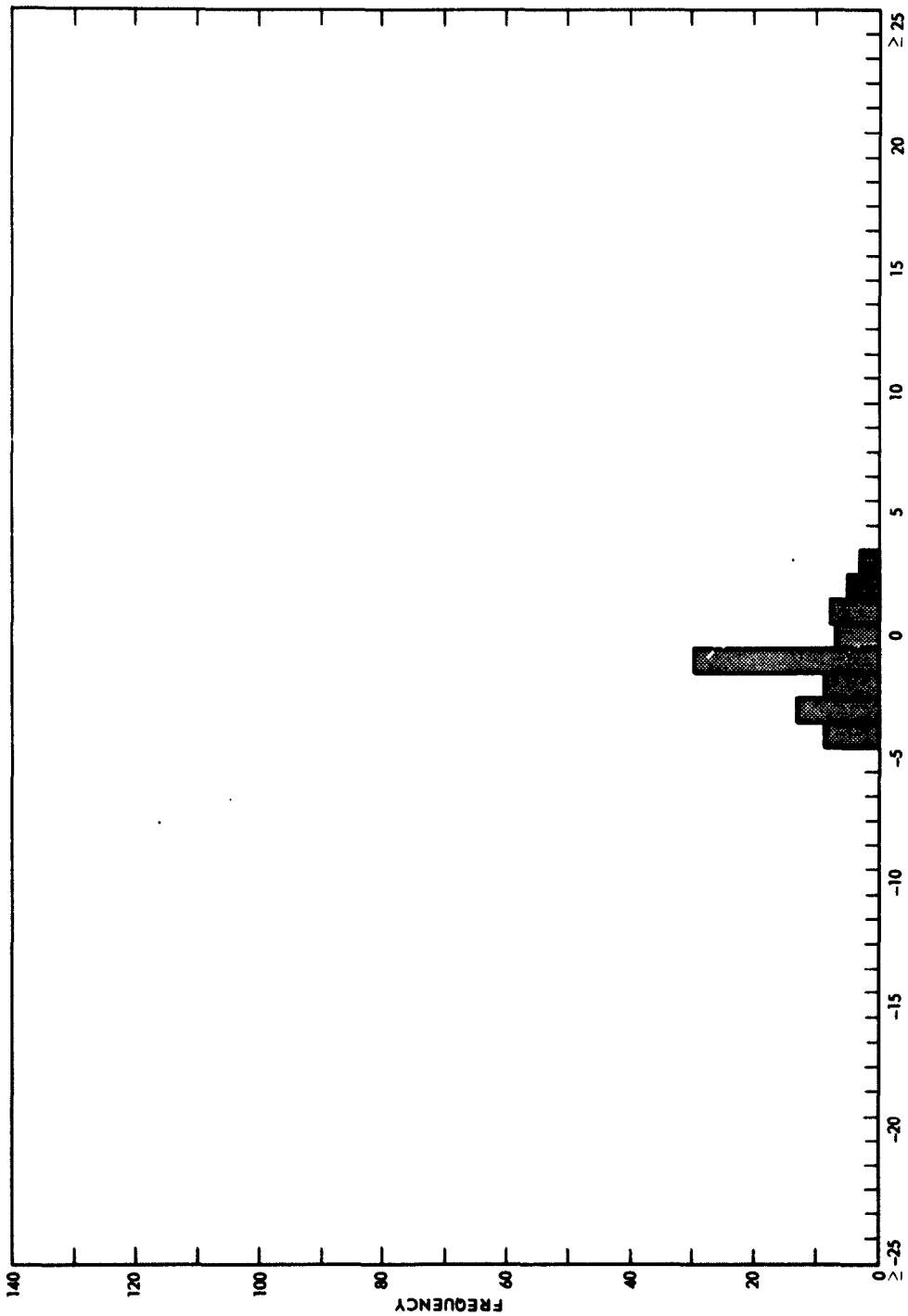


Fig. D31—Frequency Distribution of Horizontal Lay Error of APC-Mounted .50-cal Machinegun for a Range of 1050–1250 m: $n = 84$

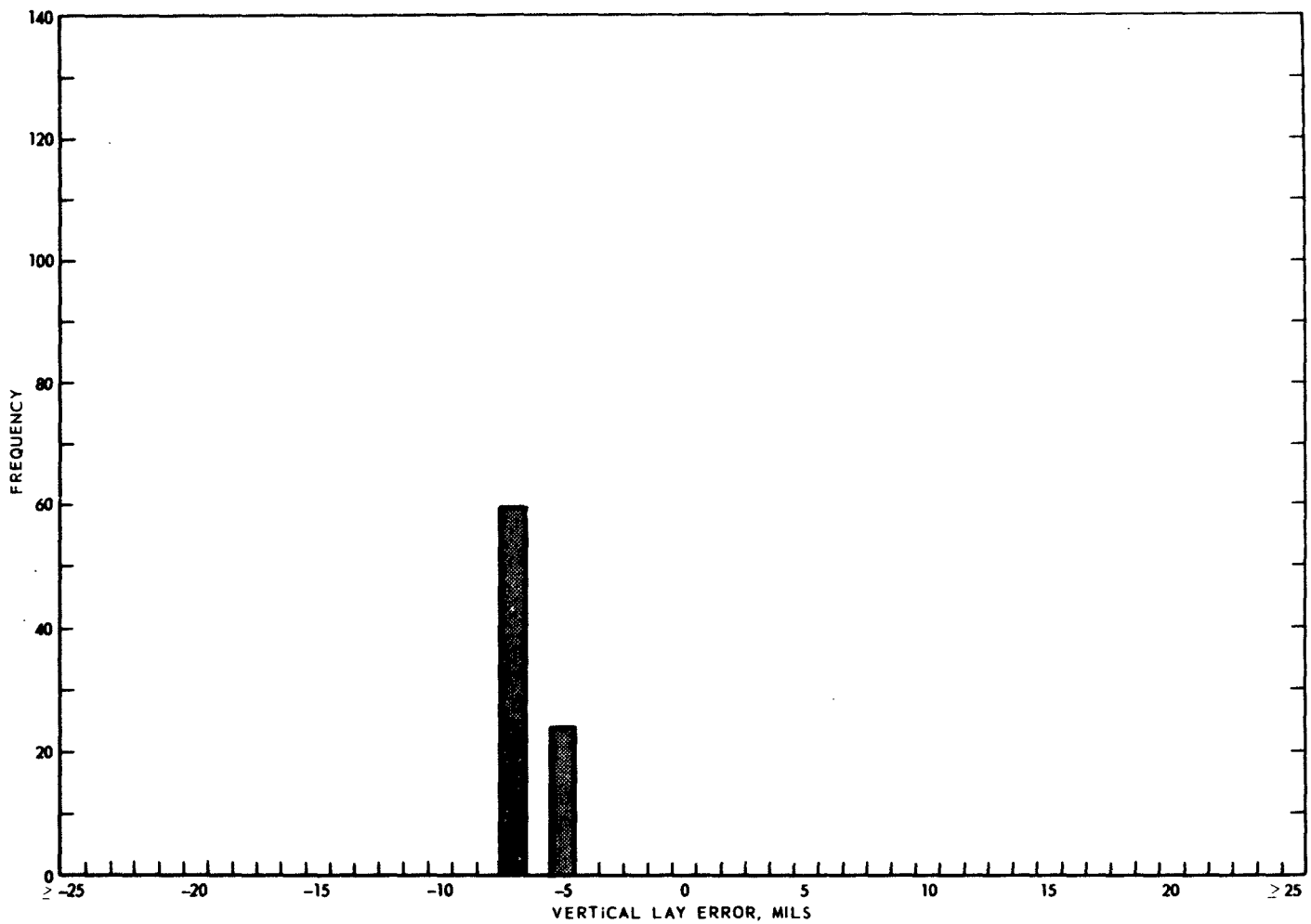


Fig. D32—Frequency Distribution of Vertical Lay Error of APC-Mounted .50-cal Machinegun for a Range of 1050–1250 m: $n = 84$

Appendix E

METEOROLOGICAL CONDITIONS

Table

Weather not only influences air-ground detection capabilities but also affects performance of the aircraft itself. The following Table E1 presents meteorological conditions existing during each of the experimental days. Data were obtained from a German air base located in the immediate vicinity of operations.

Army regulations specify the following daytime minimums for rotary wing operation: 500-ft ceiling, ½-mile visibility; and 25-knot maximum wind velocity.

Intervisibility was not affected by cloud cover or haze, nor was helicopter performance hampered by wind, temperature, or humidity.

TABLE E1

Meteorological Information Provided by Federal Republic of Germany Air Base, Roth, Germany

Day and date	Time, GMT	Wind		Visibility, NM	Temperature, °F	Relative humidity, %	Sky cover	Clouds
		Direction, deg	Speed, knots					
1 11 Jul 63	0850	240	8	5	62	72	overcast with breaks	.3 cumulus humilis, 1200 ft; .6 stratus, 4000 ft
	1150	270	8	10	64	53	overcast with breaks	.4 cumulus congestus, 2500 ft; .7 stratus, 4500 ft
	1550	270	12	15	65	48	scattered	.2 cumulus, 2500 ft; .1 cirrus fibrolus, unlimited[1]
2 12 Jul 63	0850	230	2	10	65	45	scattered	.2 cumulus congestus, 2000 ft; .1 stratus, 5000 ft
	1150	320	3	15	68	38	broken	.3 cumulus congestus, 3000 ft; .5 stratus, 4500 ft
	1550	290	6	15	70	48	broken	.2 cumulus congestus, 4000 ft; .4 stratus, 5000 ft
3 16 Jul 63	0850	240	6	15	73	54	scattered	.1 cumulus humilis, 3500 ft; .1 altocumulus, 10,000 ft
	1150	280	8	15	76	45	scattered	.4 cumulus, 3500 ft
	1550	280	10	15	79	40	scattered	.3 cumulus, 4000 ft
4 17 Jul 63	0850	light, variable		10	77	50	broken	.1 cumulus humilis, 3000 ft; .3 stratocumulus, 6000 ft; .3 altocumulus, 10,000 ft
	1150	280	7	10	76	53	broken	.1 cumulus congestus, 4000 ft; .5 stratocumulus, 6000 ft; .2 altocumulus, 9000 ft
	1550	230	5	15	78	55	broken	.1 cumulonimbus capitalus, 3500 ft; .3 cumulus congestus, 4000 ft; .5 cirrus fibrolus, unlimited[1]
5 19 Jul 63	0850	210	3	6	66	76	overcast with breaks	.5 cumulus, 2000 ft; .4 stratus, 4000 ft
	1150	250	4	7	71	63	overcast with breaks	.5 cumulus, 2000 ft; .6 stratus, 4000 ft
	1550	320	6	8	75	55	scattered	.1 cumulus congestus, 3500 ft; .1 stratocumulus, 5000 ft; .3 cirrus fibrolus, unlimited[1]

[1]Over 10,000 ft.

Appendix F

TARGETS

All target positions were selected with the help of military advisors. Primary consideration was given to a ground enemy threat. Stationary targets were tactically located, i.e., were positioned in such manner as to make good use of natural camouflage while still being afforded near-maximum line of sight and fire. Moving targets traveled on roads or paths that were either completely within wooded areas, alongside a woodline, or, when in the open, masked by high wheatfields.

Tabulation of the planned tactics for each of the 5 days of the exercise follows.

DAY 1

STATIONARY TARGETS

A, Tank

Tactical objective: To observe primary north-south road and alternate avenue of enemy advance in its sector, and provide firepower as required.

Azimuth angular field of view: 210 deg.

Maximum line of sight: 2000 m.

Average line of sight: 1200 m.

Crew: 4 men (tank commander, operating .50-cal macninegun; gunner, operating 90-mm gun; loader, observing from his hatch; driver, observing from side of vehicle).

B, Jeep (runs 3 and 4 only)

Tactical objective: To observe the portion of forward sector masked from A.

Azimuth angular field of view: 180 deg.

Maximum line of sight: 1200 m.

Average line of sight: 800 m.

Crew: 3 men (jeep commander, in vehicle; gunner, operating .30-cal machinegun; observer, in tree adjacent to vehicle).

E, Infantry Position

Tactical objective: To provide delaying action at river crossing.
Azimuth angular field of view: 120 deg.
Maximum line of sight: 700 m.
Average line of sight: 500 m.
Crew: 6 men (2 groups with gunner operating .30-cal machinegun and two observers each).

MOVING TARGETS

C, APC

Length of route: 1000 m.
Characteristics of route: 45 percent, wooded on both sides; 45 percent, wooded on one side; 10 percent, open fields on both sides.
Speed of movement: 10–20 mph except when stopped to fire.
Crew: 3 men (APC commander, operating .50-cal machinegun; driver; observer).

D, Jeep

Length of route: 500 m.
Characteristics of route: 20 percent, wooded on both sides; 30 percent, wooded on one side; 50 percent, open fields on both sides.
Speed of movement: 5–15 mph except when stopped to fire.
Crew: 3 men (jeep commander; driver; gunner operating .30-cal machinegun.

DAY 2

STATIONARY TARGETS

A, Tank

Tactical objective: To observe possible southern avenue of enemy approach in its sector and provide firepower as required.
Azimuth field of view: 270 deg.
Maximum line of sight: 2000 m.
Average line of sight: 900 m.
Crew: 4 men (tank commander, operating .50-cal machinegun; gunner, operating 90-mm gun; loader, observing from his hatch; driver, observing from side of vehicle).

B, Jeep

Tactical objective: To observe posible northern avenue of enemy approach in its sector.

Azimuth field of view: 360 deg.
Maximum line of sight: 1000 m.
Average line of sight: 500 m.
Crew: 3 men (jeep commander, in vehicle; gunner, operating .30-cal machinegun; observer, in tree adjacent to vehicle).

E, Infantry Position

Tactical objective: To observe key road junction in HS sector at Putzenreuth.
Azimuth field of view: 180 deg.
Maximum line of sight: 900 m.
Average line of sight: 700 m.
Crew: 6 men (2 groups, each with one gunner operating a .30-cal machinegun and two observers).

MOVING TARGETS

C, APC

Length of route: 1000 m.
Characteristics of route: 10 percent, wooded on both sides; 60 percent, wooded on one side; 30 percent, open fields on both sides.
Speed of movement: 5–15 mph except when stopped to fire.
Crew: 3 men (APC commander, operating .50-cal machinegun; driver; observer).

D, Jeep

Length of route: 400 m.
Characteristics of route: 60 percent, wooded on one side; 40 percent, open fields on both sides.
Speed of movement: 5–10 mph except when stopped to fire.
Crew: 3 men (jeep commander; driver; gunner, operating .30-cal machinegun.

DAY 3

STATIONARY TARGETS

A, Tank

Tactical objective: To provide defensive firepower for committed assembly area.
Azimuth angular field of view: 250 deg.
Maximum line of sight: 800 m.
Average line of sight: 500 m.

Crew: 4 men (tank commander, operating .50-cal machinegun; gunner, observing from top of tank; loader, observing from his hatch; driver, observing from side of vehicle).

B, Jeep

Tactical objective: To observe sector to rear of assembly area.
Azimuth angular field of view: 300 deg.
Maximum line of sight: 900 m.
Average line of sight: 500 m.
Crew: 3 men (jeep commander, in vehicle; gunner, operating .30-cal machinegun; observer, in bushes adjacent to vehicle).

C, APC

Tactical objective: To provide defensive firepower for committed assembly area.
Azimuth angular field of view: 150 deg.
Maximum line of sight: 900 m.
Average line of sight: 700 m.
Crew: 3 men (APC commander, operating .50-cal machinegun; 2 observers in vehicle).

D, APC

Tactical objective: To fire mortars at Schwabach (simulated).
Azimuth angular field of view: 150 deg.
Maximum line of sight: 800 m.
Average line of sight: 400 m.
Crew: 2 men (APC commander, operating .50-cal machinegun; observer, on top of vehicle).

E, Jeep

Tactical objective: To observe sector forward of assembly area.
Azimuth angular field of view: 180 deg.
Maximum line of sight: 800 m.
Average line of sight: 500 m.
Crew: 3 men (jeep commander, in vehicle; gunner, operating .30-cal machinegun; observer, in bushes adjacent to vehicle).

DAY 4

STATIONARY TARGETS

A, Tank

Tactical objective: To observe sector west of perimeter defense and and provide firepower as required.

Azimuth angular field of view: 120 deg.
Maximum line of sight: 1200 m.
Average line of sight: 700 m.
Crew: 4 men (tank commander, operating .50-cal machinegun; 2 observers on vehicle; one observer alongside vehicle in woodline).

B, Jeep

Tactical objective: To observe sector east of perimeter defense.
Azimuth angular field of view: 210 deg.
Maximum line of sight: 700 m.
Average line of sight: 400 m.
Crew: 3 men (jeep commander, in vehicle; gunner, operating .30-cal machinegun; observer, in vehicle).

C, Infantry Position

Tactical objective: To observe sector south of perimeter defense.
Azimuth angular field of view: 200 deg.
Maximum line of sight: 400 m.
Average line of sight: 200 m.
Crew: 6 men (2 groups, each with one gunner, operating .30-cal machinegun, and two observers).

D, APC

Tactical objective: To observe sector north of perimeter defense.
Azimuth angular field of view: 210 deg.
Maximum line of sight: 500 m.
Average line of sight: 300 m.
Crew: 3 men (APC commander, firing .50-cal machinegun; 2 observers on vehicle).

E, Jeep (runs 3 to 6 only)

Tactical objective: To observe sector south of perimeter defense.
Azimuth angular field of view: 180 deg.
Maximum line of sight: 400 m.
Average line of sight: 300 m.
Crew: 3 men (jeep commander, in vehicle; gunner operating .30-cal machinegun; observer, in vehicle).

MOVING TARGETS

E, Jeep (runs 1, 2 only)

Length of route: 500 m.
Characteristics of route: 80 percent, wooded on both sides; 20 percent, wooded on one side.
Speed of movement: 10–20 mph.
Crew: 3 men (jeep commander; driver; gunner, operating .30-cal machinegun.

MOVING TARGETS

A, APC

Length of route: 2000 m.
Characteristics of route: 100 percent, open fields on both sides.
Speed of movement: 5 mph.
Crew: 3 men (APC commander, operating .50-cal machinegun; driver; observer).

B, APC

Length of route: 2000 m.
Characteristics of route: 100 percent, open fields on both sides.
Speed of movement: 5 mph.
Crew: 3 men (APC commander, operating .50-cal machinegun; driver; observer).

C, APC (run 2 only)

Length of route: 2000 m.
Characteristics of route: 100 percent, open fields on both sides.
Speed of movement: 5 mph.
Crew: 3 men (APC commander, operating .50-cal machinegun; driver; observer).

D, Jeep

Length of route: 2500 m.
Characteristics of route: 60 percent, wooded on both sides; 40 percent, open fields on both sides.
Speed of movement: 5–15 mph.
Crew: 3 men (jeep commander; gunner, operating .30-cal machinegun; driver).

E, Jeep

Length of route: 2500 m.
Characteristics of route: 5 percent, wooded on both sides; 40 percent, wooded on one side; 55 percent, open fields on both sides.
Speed of movement: 5–15 mph.
Crew: 3 men (jeep commander; gunner, operating .30-cal machinegun; driver)

REFERENCES

1. Canadair Limited, "Aircraft Vulnerability Studies," SWE-00-106, 23 Mar 59. SECRET
2. Gen Hamilton H. Howze et al., "Proposed Long-Range Research and Development Program for the Army, 1960-1970 (U)," Vol VII, "The Role of Army Aviation (U)," Operations Research Office, ORO-SP-29, Oct 57. CONFIDENTIAL
3. Canadair Limited, "Survivability of Aircraft Flying Nap of the Earth," CLASP 1013, Mar 61. SECRET
4. ———, "Aircraft Vulnerability Studies," SWE-00-106, 23 Mar 59. SECRET
5. T. Donald Dixon et al., "An Evaluation of a Gun Camera as an Aid in Tank-Gunnery Training," Research Analysis Corporation, RAC-SP-190, 21 Jan 63. UNCLASSIFIED
6. Andrew J. Eckles et al., "A Preliminary Investigation of Helicopter-vs-Tank Operations," Research Analysis Corporation, RAC-TP-83, 14 Dec 62. UNCLASSIFIED
7. Bernard Astle, " Statistics in Research," Iowa State University Press, Ames, Iowa, 1963.
8. Clyde Kramer, "Extension of Multiple Range Tests to Group Means with Unequal Number of Replications, Biometrics, 307-10 (1956).